JOURNAL OF DAIRY SCIENCE

Contents

Influence of Roughages on Certain Biochemical Properties of Milk. V. N. Krukovsky, G. W. Trimberger, K. L. Turk, J. K. Loosli, and C. R. Henderson 1

The Use of Anthrone for the Quantitative Estimation of Lactose in Dairy Products. H. J. Fagen, Elizabeth Sibbach, and R. V. Hussong 10

Management Practices and Net Returns in Milk Production in Washington. E. L. Baum, C. W. Mey, A. O. Shaw, and H. G. Walkup 14

Relationship Between Titratable Acidity and pH During Lactic Acid Fermentation in Reconstituted Nonfat Milk. H. H. Wilkowske 22

Blood Studies of Breeding Dairy Bulls. I. Hematrocrit, Hemoglobin, Plasma Calcium, Plasma Inorganic Phosphorus, Alkaline Phosphatase Values, Erythrocyte Count, and Leucocyte Count. L. L. Rusoff, J. E. Johnston, and Cecil Branton 30

Bacteriological Studies on High-Temperature Short-Time Pasteurization of Ice Cream Mix. M. L. Speck, C. A. Groschie, H. L. Lucas, Jr., and L. Hankin 37

The Influence of Glycerol Level, Various Temperature Aspects and Certain Other Factors on the Survival of Bull Spermatozoa at Sub-Zero Temperatures. W. J. Miller and N. L. Vandemark 45

Sulfur Dioxide as a Preservative for High Moisture Legume Silage. L. Dufour, R. P. Niedermeier, C. E. Zehner, and J. W. Crowley 52

The Effect of the Ensiling Process on Wild Onion and Ragweed Flavors in Silage and in Milk. R. E. Brubaker and P. M. Reaves 58

Fat Separation in Evaporated Milk. I. Homogenization, Separation, and Viscosity Tests. R. B. Maxcy and H. H. Sommer 60

The Analysis of Errors in Assaying Fecal Androgens in the Dairy Cow. A. Grandage, R. B. Casady, and H. L. Lucas 72

Some Nutritional Requirements of Bovine Rumen Bacteria. J. J. McNeill, R. N. Doetsch, and J. C. Shaw 81

Degree of Herbage Selection by Grazing Cattle. W. A. Hardison, J. T. Reid, C. M. Martin, and P. G. Woolfolk 89

Information for Authors 103

People and Events 107

Letters to the Editor 111

Our Industry Today 113

Association Announcements 119

Officers and Committees of the Association 121

Membership Directory 125

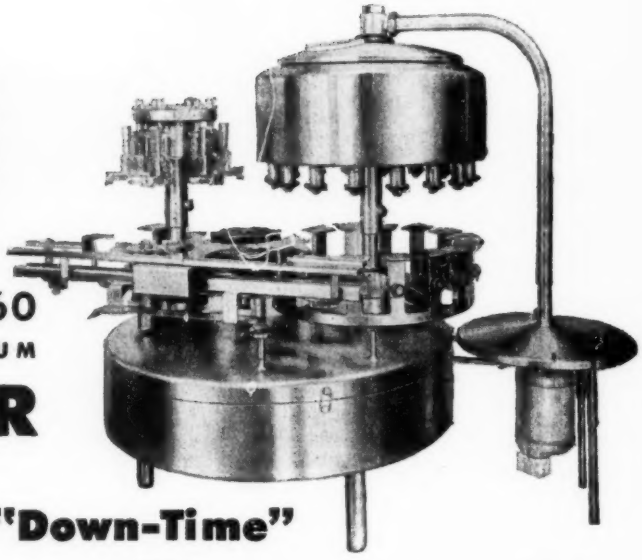
Abstracts of Literature A1

Vol. XXXVII, No. 1, January, 1954

Published by the

AMERICAN DAIRY SCIENCE ASSOCIATION

GET A



Model 160
STAINLESS VACUUM
FILLER

...and Cut "Down-Time"
ALL ALONG THE LINE

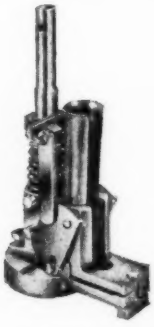
The No. 160 CP Filler is designed and built to give long, uninterrupted filling runs. With your entire plant production line keyed to filler performance, dependable CP Filler operation cuts down-time costs *all along the line.*

Just one of many reasons for dependable operation is capper design. The CP Filler has more cappers for the number of filling valves than any other filler. Six cappers to 16 *drip-proof* filling valves permit lower capper speeds which reduces capper wear and cuts the possibilities of breakdowns.

Easy disassembly speeds cleaning. With all external parts of stainless steel or nickel alloy, the CP Filler stays as sanitary and neat appearing years from now as when new.

The No. 160 Filler handles half pints to half gallons—square, rectangular and round. Write for a full description in a free copy of Bulletin F-913 or see your CP representative.

For smaller operations, ask for information on the CP No. 100 Filler.



WORLD'S FINEST CAPPING HEAD

The CP Stainless Steel Take-Down Capping Head is recognized and accepted by the entire dairy industry as the finest on the market. Can be completely disassembled without tools in two minutes.

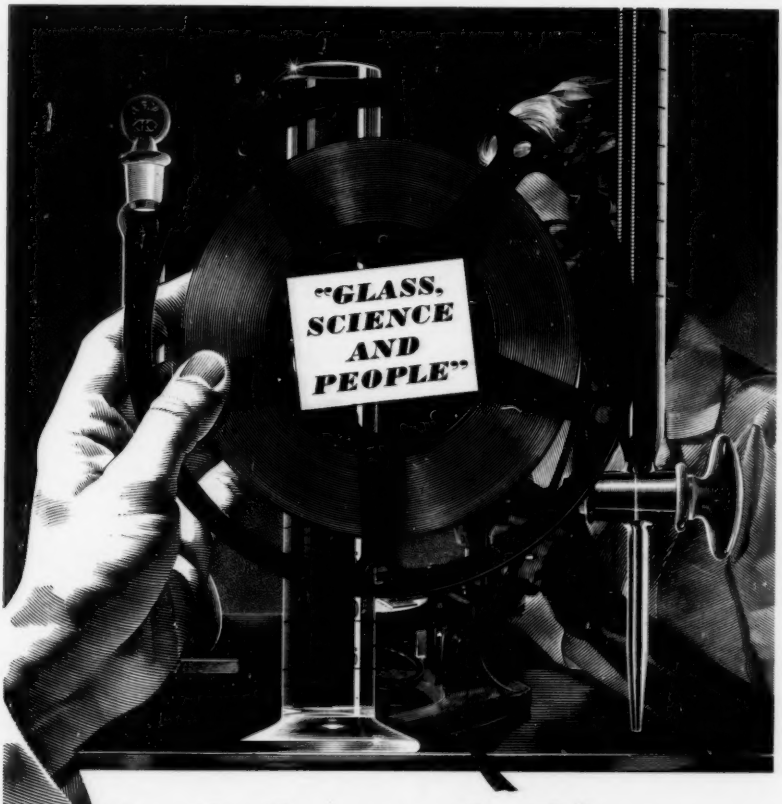
THE *Creamery Package* MFG. COMPANY

General and Export Offices: 1243 W. Washington Blvd., Chicago 7, Ill.

Branches: Atlanta • Boston • Buffalo • Chicago • Dallas • Denver • Houston • Kansas City, Mo. Los Angeles • Minneapolis • Nashville • New York • Omaha • Philadelphia • Portland, Ore. St. Louis • Salt Lake City • San Francisco • Seattle • Toledo • Waterloo, Ia.

Creamery Package Mfg. Co. of Canada, Ltd.
267 King St., West, Toronto 2, Ontario

The Creamery Package Mfg. Company, Ltd.
Mill Green Road, Mitcham Junction, Surrey, England



Ready for your bookings now

. . . an instructive and entertaining film for all who work with scientific glassware

Kimble Glass Company takes pleasure in presenting for immediate booking its new film, *Glass, Science and People*. Here is a fascinating story of laboratory glassware.

Anyone who works with laboratory equipment . . . your Chemical Society . . . research groups . . . schools . . . hospital staffs . . . will find *Glass, Science and People* intensely interesting—highly informative. To reserve booking time for your group, write: Kimble Scientific Division, Owens-Illinois, Box 1035, Toledo 1, Ohio.

KIMBLE DAIRY TEST WARE
AN (O) PRODUCT

OWENS-ILLINOIS
GENERAL OFFICES • TOLEDO 1, OHIO

Your advertisement is being read in every State and in 45 Foreign Countries

JOURNAL OF DAIRY SCIENCE

OFFICIAL ORGAN OF
AMERICAN DAIRY SCIENCE ASSOCIATION

Published at
119-123 WEST PARK AVENUE, CHAMPAIGN, ILLINOIS

P. H. TRACY, *Editor*
Urbana, Illinois

Editorial Board

J. O. ALMQUIST, State College, Pa. — R. E. ELY, Washington, D. C. — J. P. MIXNER, Sussex, N. J. — R. L. PERRY, Los Angeles, Calif.
F. J. DOAN, State College, Pa. — ROBERT JENNESS, St. Paul, Minn. — E. E. ORMISTON, Urbana, Ill. — M. L. SPECK, Raleigh, N. C.
R. W. TOUCHBERRY, Urbana, Ill. — EVERT WALLENFELDT, Madison, Wis.

Committee on Journal Management

R. E. HODGSON, *Chairman*
J. H. ERB — P. H. TRACY (ex officio)
K. L. TURK — P. R. ELLSWORTH (ex officio)

Manuscripts for publication in the Journal should be submitted to the editor, P. H. Tracy, Department of Food Technology, University of Illinois, Urbana. See Vol. 37, January issue, page 103 for information concerning the preparation of manuscripts.

Subscriptions. Price, $10.00 per volume in North and South America; $10.50 in all other countries. Prices are net, postpaid. New subscriptions and renewals are entered to begin with the first issue of the current volume. Renewals should be made promptly to avoid a break in the series. Subscriptions should be sent to P. R. Ellsworth, The Ohio State University, Columbus 10, Ohio.

Subscriptions for the British Isles and British Empire, except for Canada and Australia, should be ordered through our agents: Messrs. Bailliere, Tindall and Cox, 7 and 8 Henrietta Streets, Covent Garden, London, W. C. 2, England. Subscriptions for Australia should be sent to our agent: John H. Bryant, Herbert St., St. Leonards, N. S. W., Australia.

Advertising copy should be mailed to P. R. Ellsworth, The Ohio State University, Columbus 10, Ohio. Advertising plates or cuts should be mailed direct to The Garrard Press, 119-123 West Park Ave., Champaign, Illinois.

Post office notices of undeliverable copies and changes of address should be sent to P. R. Ellsworth at the address above stated.

OFFICERS OF THE ASSOCIATION

W. V. PRICE, *President*, Madison, Wis. — P. R. ELLSWORTH, *Sec.-Treas.*, Columbus, Ohio
L. A. MOORE, *Vice-President*, Washington, D. C. — P. H. TRACY, *Journal Editor*, Urbana, Illinois

DIRECTORS

N. N. ALLEN, Madison, Wis. — I. A. GOULD, Columbus, Ohio — H. B. HENDERSON, Athens, Ga. — D. V. JOSEPHSON, State College, Pa.
E. J. PERRY, New Brunswick, N. J. — L. H. RICH, Logan, Utah — G. W. SALISBURY, Urbana, Ill.

Entered as second-class matter at the post office at Champaign, Illinois, under the act of March 3, 1879.

Your advertisement is being read in every State and in 45 Foreign Countries

SURGE

Whoever you are or wherever you happen to be—if you know of some dairy farmer who is making bad milk because he has a dirty Surge Milker, please tell us who he is and where he lives.

We can help him get straightened out and on the right road and we can do it promptly.

We can't guarantee that he will keep on the road but we can give him a fresh start.

BABSON BROS. CO.

2843 West 19th Street • Chicago 23, Illinois

ATLANTA • HOUSTON • KANSAS CITY • MINNEAPOLIS
SACRAMENTO • SEATTLE • SYRACUSE • TORONTO

Copyright 1954, Babson Bros. Co.

Your advertisement is being read in every State and in 45 Foreign Countries

"HANSEN'S"
DAIRY PREPARATIONS
For High Quality Dairy Products

- ☐ CHEESE RENNET AND COLOR
- ☐ COTTAGE CHEESE COAGULATOR
- ☐ ANNATTO BUTTER COLOR
- ☐ DANDELION BUTTER COLOR
- ☐ CERTIFIED BUTTER COLOR
- ☐ STARTER DISTILLATE
- ☐ ICE CREAM COLOR
- ☐ LACTIC FERMENT CULTURE
- ☐ CULTURE FLASKS
- ☐ CULTURE CABINETS
- ☐ TESTING SOLUTIONS
- ☐ ODORLESS TYPE DAIRY FLY SPRAY

Reliable Service Since 1878

Check and Mail for Literature

CHR. HANSEN'S LABORATORY, INC.
MILWAUKEE 14, WIS.

LOW IN COST—
HIGH IN QUALITY

UNIFORMITY IS IMPORTANT! Leading agricultural schools and colleges agree that the regular weekly use of FLAV-O-LAC FLAKES assures uniformity of smoothness, aroma and flavor in fermented milk products.

YOGHURT CULTURE

FLAV-O-LAC FLAKES (shown) produce a quart of the finest starter on a single propagation. Single bottles $2.00.

SPECIAL FLAV-O-LAC FLAKES "40"
produce 40 quarts of starter on a single propagation. Single bottles $3.75. Plus postage. Free Cultural Manual of Fermented Milk Products on request.

THE
DAIRY LABORATORIES
DALARB ASSOCIATES
23rd & Locust Sts., Phila. 3, Pa.
BRANCHES
New York Baltimore Washington
See our catalog in Dairy Industries Catalog

Copies of the

20-YEAR INDEX

covering Volumes I to XX, inclusive are available at the following prices:

•

MEMBERS

Cloth Bound $2.35
Paper Bound 2.00

•

NON-MEMBERS

Cloth Bound $5.50
Paper Bound 5.00

JOURNAL OF DAIRY SCIENCE

VOLUME XXXVII January, 1954 NUMBER 1

INFLUENCE OF ROUGHAGES ON CERTAIN BIOCHEMICAL PROPERTIES OF MILK

V. N. KRUKOVSKY, G. W. TRIMBERGER, K. L. TURK, J. K. LOOSLI, AND C. R. HENDERSON

New York State College of Agriculture, Cornell University, Ithaca, New York

Evidence indicates that roughages and supplements fed to cows and the physiological response of the animal to feed are largely responsible for the biochemical make-up of milk that regulates its oxidative changes. Conflicting views are expressed in the literature on the part played by some of the milk constituents in the promotion or retardation of oxidative processes that result in the development of objectionable flavors. The reason for these divergent opinions may well be the variable feeding conditions and laboratory methods under which milk is produced and studied *(14)*. Consequently, a new factor is often brought to light, which, with as yet unknown systems involved, leads to subjective interpretation of the results obtained.

In a series of studies *(1, 2, 6, 7, 8, 9, 10, 14, 15, 17, 23)* it has been shown not only that the carotene, vitamin A, and tocopherol content of the milk fat vary with the type and quality of the roughages and supplements fed to the cow but that a relationship exists between the tocopherol content of the milk fat and the ability of milk to resist reactions that produce oxidized flavors. Furthermore, there is reason to believe that certain roughages impart unidentified compounds to the watery phase of milk which influence the oxidative processes. Apparently, the preferential oxidation of these compounds in the milk causes the postponement or prevention of reactions that produce the oxidized flavors, depending upon the availability of ascorbic acid and copper during storage *(11, 12, 13, 14)*.

The present paper reports data on the assimilation and deposition of the fat-soluble vitamins and the antioxidant properties of the fat and plasma phases of the milk as influenced by varietal factors, such as the seasonal trends for the plant species, the method of storage for the roughage, and the physiological response of the cow to the feed consumed.

EXPERIMENTAL

Twelve Holstein cows divided into three groups according to age, stage of lactation, and production were used for this study during the winter season of 1951-52.

After a preliminary period of 3 weeks, during which the cows received a ration of mixed hay as the only roughage, the feeding experiment was performed

Received for publication April 6, 1953.

according to the change-over design to test four roughages in four 5-week periods. The four roughages used, together with the time of cutting and stages of maturity, were as follows: early-cut silage, June 1, timothy heads in boot; early-cut, barn-cured hay, June 18, timothy headed, but prebloom; late silage and field-cured hay, cut at the same time on July 10 with the timothy in full bloom.

The roughages were harvested from the same field and divided into plots with uniform herbage composition. The mixed legume-grass stand was typical of the kind of herbage that prevails in New York State. The average composition was approximately 50% clover (medium red and alsike); 25 to 30% grass (predominantly timothy with some quack grass, red top, blue grass, and orchard grass); 5 to 10% alfalfa, and 16% foreign matter (largely yellow rocket weed). The cows were given all of one kind of roughage they were able to eat, plus an average of 10.4 lb. of grain concentrate mixture per day during the 20 weeks of the experiment.

A sample of milk was taken from each cow of the night and morning milkings at the end of each of the four 5-week periods. The composite samples made for each cow early in the morning were pasteurized at 61° C. for 30 minutes. Each of the 12 samples of milk was subdivided into six aliquot portions for studies on tocopherol, vitamin A, and carotenoid contents of the fat, and on the susceptibility of milk to oxidative deterioration in the presence of 0.1, 0.5, and 1.0 mg. Cu per liter. The catalyst was added to milk first precooled to 20° C. Subsequently, all portions of milk were held at 0° to 5° C. in glass bottles protected from the light. Changes in the palatability of the milk were determined organoleptically daily during a 10-day holding period.

At the end of 3 days storage, gravity cream and skimmilk of duplicate samples, which remained undisturbed during storage, were carefully separated by siphoning. The cream was churned and the fat was oiled, centrifuged, and analyzed for its vitamin content.

Tocopherol contents of the fat, liophylized roughages, and grain mixture were assayed, using a four-unit semimicro still, as described by Quaife and Biehler *(21)* and Quaife and Harris *(22)*. The carotene content of the roughages was determined by the extraction procedure outlined by Moore and Ely *(19)*, and the pigments were chromatographically separated in a soluble starch-Hyflo Super-Cel column (3 parts starch–1 part Super-Cel). The concentration of the extracted pigments was measured against a B-carotene standard (General Biochemicals 90% beta, 10% alpha) using filter No. 440. Vitamin A and carotenoids of the fat were determined by the Koehn and Sherman method *(3)*.

RESULTS

Tocopherol and carotene levels of silages and hays. The average values for tocopherols and carotene content of the roughages fed to the cows, the average daily roughage intakes, and daily milk production are presented in Table 1. It can be seen that the tocopherol and carotene content of the roughages was influenced by the seasonal trends for the plant species and the method of preservation for the roughage. As an average, the early silage was higher in tocopherol and

carotene content than any other roughage. The field-cured hay was uniformly lower in tocopherol and carotene content, whereas the late silage and the barn-cured hay were intermediate.

Tocopherol, total vitamin A, and carotenoid levels of the milk fat. The average

TABLE 1

The average daily roughage intakes, average daily milk production, and the vitamin content of the roughages

Roughage	Av. daily intake		Av. daily production		Av. content[a]	
	As fed	Dry matter	Actual milk	Fat test	Total tocopherols[b]	Carotene
	(lb.)	*(lb.)*	*(lb.)*	*(%)*	*(γ/g.)*	*(γ/g.)*
Early silage	117.5	27.1	44.6	3.5	470 ± 64	422 ± 102
Late silage	91.9	22.4	37.7	3.4	349 ± 34	160 ± 47
Early barn-cured hay	32.7	28.0	40.4	3.6	142 ± 24	27 ± 11
Late field-cured hay	30.5	25.9	37.2	3.7	107 ± 18	16 ± 6

[a] Determined on the liophylized samples (dry matter basis).
[b] The grain mixture contained 100 γ/g. of tocopherols and a trace of carotene. Av. daily intake, 10.4 lb.

values for tocopherol, total vitamin A, and carotenoid content of the milk fat produced by 12 cows at the end of each of the four 5-week periods on the particular roughage studied are presented in Table 2. The data in Tables 1 and 2 show that in general the tocopherol, total vitamin A value, and carotenoid levels of the fat reflect the intakes of vitamins on the particular roughage studied. The analysis of variance presented in Table 3 indicates that the differences in the average tocopherol, total vitamin A value, and carotenoid content of the fat, as affected by the roughages fed to the cows, were statistically highly significant ($P < 0.01$). Likewise, the differences in the average total vitamin A value and carotenoid content of the fat as affected by the individual cows were found to be significant.

Under the experimental conditions described, the cow and the period, as a source of variance, produced no significant effect on the tocopherol levels of the fat.

TABLE 2

Average tocopherol, total vitamin A value and carotenoid content per 100 g. of milk fat[a]

Roughage	Tocopherol	Total vitamin A value[b]	Carotenoids
	(γ)	*(γ)*	*(γ)*
Early silage	3,090 ± 263	1,037 ± 178	550 ± 117
Late silage	2,614 ± 323	809 ± 114	323 ± 100
Early barn-cured hay	2,120 ± 554	778 ± 116	373 ± 50
Late field-cured hay	1,837 ± 501	692 ± 70	259 ± 55

[a] Av. of 12 observations on each roughage.
[b] 0.6 γ of carotene and 0.3 γ of vitamin A are equal each to 1 I.U. of vitamin A.

TABLE 3
Analysis of variance

Source of variation	d. f.	Mean squares	F
		Tocopherols	
Among cows	11	125,244	
Among periods	3	68,212	
Among roughages	3	3,642,984	24.2[a]
Error	30	150,779	
Total	47		
		Carotenoids	
Among cows	11	20,824	6.61[a]
Among periods	3	8,568	2.72
Among roughages	3	186,718	59[a]
Error	30	3,149	
Total	47		
		Total vitamin A	
Among cows	11	36,882	3.77[a]
Among periods	3	15,973	1.63
Among roughages	3	260,057	26.6[a]
Error	30	9,772	
Total	47		

[a] $P < 0.01$

TABLE 4
Average daily intakes of tocopherol and carotene and the vitamin content of the milk

Roughages consumed	Intakes from roughages and concentrate		Content of milk produced		Carotene-tocopherol ratio in the feed	Per cent vitamin intake transmitted to milk	
	Total tocopherol[a]	Carotene	Tocopherol	Total vit. A value		Tocopherol	Vit. A
	(mg.)	*(mg.)*	*(mg.)*	*(mg.)*	1 to:	*(%)*	*(%)*
Early silage	6,249	5,187	21.88	7.34	1.20	0.35	0.28
Late silage	4,018	1,626	15.20	4.70	2.47	0.37	0.57
Early barn-cured hay	2,275	343	13.98	5.13	6.63	0.61	2.99
Late field-cured hay	1,729	188	11.47	4.32	9.19	0.66	4.59

[a] Tocopherol daily intake alone from concentrate mixture of ground corn and oats, distillers' dried corn grains, wheat bran, soybean oil meal, steamed bone meal, and iodized salt, was equivalent to 471.7 mg.

The average daily intakes of tocopherol and carotene and the vitamin content of the milk. The data in Table 4 indicate that the assimilation and utilization of carotene by an animal body, and thus the total vitamin A activity of the milk produced, are influenced by the tocopherol intake of the ration.

Calculated average intakes of tocopherols and carotene on the particular roughage studied have shown that with an increase in tocopherol-carotene ratio from 1:1 to 10:1 the per cent of vitamin A intake in the diet (calculated from carotene) that was transmitted to milk increased from 0.28 to 4.59%. It appears

that carotene was more efficiently utilized from the roughages with lower carotene contents, such as barn and field cured hays, than from the early silage.

In general, this work bears out our previous observations *(4, 6, 7, 8, 10, 15, 17, 23)* and the recent studies of McGillivray *(18)*.

Oxidized flavors. The data showing the samples of milk which in the presence of 0.1 mg. of Cu per liter either underwent or resisted the oxidative deterioration during storage are presented in Table 5 (milk containing 0.5 mg. or more of Cu per liter was omitted).

TABLE 5

The influence of roughages on the susceptibility of milk to the development of oxidized flavors in the presence of added copper (0.1 mg. per liter)

	Samples of milk which either underwent or resisted the oxidized flavors during 10 days storage at 0-5° C.				
	Type of roughages fed				
Cow No.	Prefeeding control	Early silage	Late silage	Early barn-cured hay	Late field-cured hay
1	+	+	−	+	+
2	+	+	−	+	+
3	+	+	−	+	+
4	+	+	−	+	+
5	+	+	−	+	+
6	+	?	−	+	?
7	+	−	−	+	−
8	−	+	−	−	−
9	−	−	−	−	−
10	−	+	−	−	9[a]
11	−	−	−	−	−
12	−	−	−	−	−

Note: + = Unstable milk—developed oxidized flavors during first 3 days of storage.
− = Stable milk—oxidized flavors were not detected during 10 days of storage.
[a] Oxidized flavor developed 9th day.

The data reveal that, irrespective of the sequence of feeding, the milk produced on late silage had acquired the ability to resist the reactions that produce the oxidized flavors even in the presence of 1.0 mg. of copper. All of these samples retained their initial palatability during 10-day storage at refrigeration temperatures.

By comparison, the resistance of milk to oxidized flavors was appreciably reduced when the early silage, barn-cured hay, and field-cured hay were substituted in the ration. Of these samples 53% became unpalatable during the first 3 days of storage, and 47% remained stable at the end of 10 days. In this connection it is of interest to note that, regardless of the tocopherol content of the fat, the cows that produced relatively stable milk at the end of a preliminary feeding trial have shown a tendency on all experimental roughages to produce milk having greater resistance to copper catalysis of oxidized flavors.

DISCUSSION

It seems from the data which have been presented that the tocopherol levels of the milk fat varied with roughage only and that this vitamin may play a part in assimilation and utilization of carotene by an animal body.

Although the vitamin A and carotenoid levels of the fat were governed primarily by the type and quality of the roughages fed to the cow and the physiological response of the animal to the feed consumed, other causes superimposed upon these two may have produced certain effects to modify the vitamin content of the fat. One is possibly related to the stability of chromogens in acid medium.

Even though no attempt has been made to determine the effects of acid-stomach digestion on the carotene intakes of the roughages consumed, the data in Tables 1 and 2 indicate that it might be a contributing factor. The data show the deposition of 809 $\pm$ 114 γ and 778 $\pm$ 116 γ of total vitamin A value, on the average, per 100 g. of fat produced on late silage and early barn-cured hay rations, respectively, in spite of the wide variation in their carotene intakes (1.625 and 0.3429 g. total average daily consumption). In this connection, however, the following observations were made, when, instead of hydrogenation technique *(21)*, the Parker and McFarlane method *(20)* was applied to molecular distillates of roughage extracts *(16)*. In this method sulfuric acid and potassium hydroxide are used to treat oil in petroleum ether solution to decolorize carotene before Emmerie-Engel reaction.

It was found that time in which molecular distillates became colorless varied with the specific gravity of the acid used, maturity of the plant, and preservation method. The time in which distillates were decolorized completely while in contact with 1.785 s.g. sulfuric acid was: early silage, 48 hours; late silage, 1 hour; early barn-cured hay, 1 minute; and the late field-cured hay, immediately. When 1.805 s.g. sulfuric acid was used, the distillates of early and late silages became colorless in 60 and 2 minutes, respectively. Likewise, the acid destruction of chromogens in the distillates was appreciably retarded when pure alpha or gamma tocopherols were added to the reaction mixture in the recovery studies *(16)*.

It has already been indicated that although in this trial the cows produced stable milk only on late silage ration, nevertheless some of them have shown a tendency to produce stable milk on all experimental roughages. This influence of the physiological response of the cow to the feed consumed on the biochemical make-up of milk which controls the oxidative changes can be readily discerned from the data in Tables 2 and 5. Apparently, in addition to tocopherols, some other substances that extend their protective influence to milk are excreted by the mammary gland long after the causative ration has been discontinued.

However, it has been shown *(12, 14)* that some of the stable samples of milk with low tocopherol content might be rendered unstable and undergo deterioration resulting in the development of oxidized flavors merely upon the addition of ascorbic acid at the point of its depletion during the storage tests. Because of this it was necessary to postulate that the postponement of the reactions which produce the oxidized flavors in such milk was caused by the presence and preferential oxidation of unknown substances, named nonflavor-forming compounds, in contrast to flavor-forming ones.

As a result, the resistance of milk to oxidized flavors might be influenced

either by the excess on either side or by mutual effect of tocopherols and non-flavor-forming compounds.

Likewise, it should be remembered that the level of tocopherols necessary to protect milk against copper-enhanced oxidative processes might be determined as well by the type-distribution of unsaturated fatty acids in the lipid molecules oriented on the surface of the fat-globules and in the fat itself, as influenced by various feeds.

It cannot be stated at present whether, in this trial, the species of plants, influence of the seasonal trends, or changes induced by preservation methods were responsible for the biochemical make-up of milk controlling the oxidative processes. In another experiment *(14)*, orchard grass pasture as a rule produced a very stable milk, but ladino clover produced unstable milk *(6, 9, 14)*. The influence of these and other species may become more important with advancing maturity of the plant.

The oxidative deterioration of milk produced on early silage and early barn-cured hay rations manifested itself first by the development of metallic flavor. This flavor was superseded with previously described *(11, 12, 13, 14)* chalky-to-soapy-tallowy and then fishy flavors.

CONCLUSIONS

A study was made of the effects of roughages harvested at different stages of maturity and preserved as either silage or hay on tocopherol, vitamin A, and carotenoid content of the milk fat and the resistance of milk to oxidative changes.

As an average, the early silage was higher in tocopherol and carotene content than any other roughage. The late field-cured hay was uniformly lower in vitamin and provitamin content, whereas the late silage and early barn-cured hay were intermediate.

As an average, the fat produced on early silage ration was highest in tocopherol, vitamin A, and carotenoid content; the fat produced on late field-cured hay was lowest.

The differences in the average tocopherol, total vitamin A value, and carotenoid content of the fat samples, as affected by the roughages fed to the cows, were statistically highly significant ($P < 0.01$). Likewise, the differences in the average total vitamin A value and carotenoid content of the fat samples, as affected by the physiological response of the individual cow to the feed consumed, were significant.

Under the experimental conditions described, the cow and the period, as a source of variance, produced no significant effect on tocopherol levels of the fat.

Fifty-three per cent of samples of milk produced on early silage and barn- and field-cured hays were unstable and became unpalatable during the first 3 days of storage in the presence of 0.1 mg. per liter of added copper; 47% remained stable during 10-day storage tests at 0-5° C.

The data show that the late silage ration produced milk that effectively resisted the oxidized flavors throughout the experimental trial, even in the presence

of 1.0 mg. of Cu per liter, and yet contained 2,614 γ tocopherols per 100 g. of fat, on the average, as compared with 3,090 γ vitamin yield on the early silage ration.

The observation indicates, therefore, that in addition to tocopherols some roughages fed to the cow contain other protective substances influencing the oxidative processes and that their excretion by the mammary gland is mainly responsible for the stability of milk with 3,000 γ tocopherols per 100 g. of fat and below, when both ascorbic acid and copper act as the catalysts.

The data suggest that the prevention, or practical postponement, of the reactions which result in the development of oxidized flavors was affected in the late silage milk by the presence and preferential oxidation of the unknown substances, named nonflavor-forming compounds. Apparently, some of the animals continued to excrete these substances long after the causative ration has been discontinued.

REFERENCES

(1) Bauman, C. A., Steenbock, H., Beeson, W. M., and Rupel, I. W. The Influence of Breed and Diet of Cows on the Carotene and Vitamin A Content of Butter. *J. Biol. Chem.*, **105**: 167. 1934.

(2) Beck, G. H., Whitnah, C. H., and Martin, W. H. Relation of Vitamin C, Lecithin and Carotene of Milk to the Development of Oxidized Flavor. *J. Dairy Sci.*, **22**: 17. 1939.

(3) Koehn, C. J., and Sherman, W. C. The Determination of Vitamin A and Carotene with Photoelectric Colorimeter. *J. Biol. Chem.*, **132**: 527. 1940.

(4) Krukovsky, V. N. The Carotenoid Content of Milk Fat Fractions. *J. Dairy Sci.*, **25**: 297. 1942.

(5) Krukovsky, V. N., and Guthrie, E. S. Vitamin C, Hydrogen Peroxide, Copper and the Tallowy Flavor in Milk. *J. Dairy Sci.*, **29**: 293. 1946.

(6) Krukovsky, V. N. Lipid Deterioration in Dairy Products. The Effect of Varying the Tocopherol Content of the Milk Fat through Feeding on the Stability of Fresh Milk. *Final Report*, No. 13. Phase IV, Committee on Food Research, Quartermaster Food and Container Inst. for the Armed Forces. Sept. 1948.

(7) Krukovsky, V. N., and Whiting, F. Co-vitamin Studies of the Milk Fat from Four Breeds of Dairy Cattle (Abs.). *J. Dairy Sci.*, **31**: 666. 1948.

(8) Krukovsky, V. N., Loosli, J. K., and Whiting, F. The Influence of Tocopherols and Cod Liver Oil on the Stability of Milk. *J. Dairy Sci.*, **32**: 196. 1949.

(9) Krukovsky, V. N., Loosli, J. K., and Theokas, D. Preliminary Observations on the Effects of Ladino Pasture and Hay Feeding on the Tocopherol Content of the Fat and the Stability of Milk. (Abs.). *J. Dairy Sci.*, **32**: 700. 1949.

(10) Krukovsky, V. N., Whiting, F., and Loosli, J. K. Tocopherols, Carotenoids and Vitamin A Content of the Milk Fat and the Resistance of Milk to the Development of Oxidized Flavors as Influenced by Breed and Season. *J. Dairy Sci.*, **33**: 791. 1950.

(11) Krukovsky, V. N. The Origin of Oxidized Flavors and the Factors Responsible for their Development. *Abstracts*, 117th Meeting, A.C.S., 2a-4. April, 1950. Philadelphia, Pa.

(12) Krukovsky, V. N., and York, Barbara. Additional Biochemical Properties of Fresh Milk Influencing the Development of Oxidized Flavors. *J. Dairy Sci.*, **34**: 484. 1951.

(13) Krukovsky, V. N. The Origin of Oxidized Flavors and Factors Responsible for their Development in Milk and Milk Products. *J. Dairy Sci.*, **35**: 21. 1952.

(14) Krukovsky, V. N. Antioxidant Properties of Milk as Influenced by the Type of Pasture Fed to the Cows. *J. Dairy Sci.*, **35**: 481. 1952.

(15) Krukovsky, V. N., and Loosli, J. K. Further Studies on the Influence of Tocopherol Supplementation on the Vitamin Content of the Milk Fat, Stability of Milk and Milk and Fat Production. *J. Dairy Sci.*, **35**: 834. 1952.

(16) Krukovsky, V. N. Unpublished.

(17) LOOSLI, J. K., KRUKOVSKY, V. N., AND LOFGREEN, G. P. The Influence of Various Hays on the Production, Vitamin Content and Flavor of Milk (Abs.). *J. Dairy Sci.*, 31: 690. 1948.

(18) MCGILLIVRAY, W. A. The Effect of Tocopherol and Carotene Supplements on the Vitamin A potency of New Zealand Butterfat. *J. Dairy Research*, 19: 119. 1952.

(19) MOORE, L. A., AND ELY, R. Extraction of Carotene from Plant Material. A Rapid Quantitative Method. *Ind. Eng. Chem.*, Anal. ed., 13: 600. 1941.

(20) PARKER, W. E., AND MCFARLANE, W. D. A Proposed Modification of Emmerie's Iron-Dipyridyl Method for Determining the Tocopherol Content of Oils. *Can. J. Research*, 18: 405. 1940.

(21) QUAIFE, M. L., AND BIEHLER, R. A Simplified Hydrogenation Technique for the Determination of Blood Plasma Tocopherols. *J. Biol. Chem.*, 159: 663. 1945.

(22) QUAIFE, M. L., AND HARRIS, P. L. Chemical Assay of Foods for Vitamin E Content. *Anal. Chem.*, 20: 1221. 1948.

(23) WHITING, F., LOOSLI, J. K., KRUKOVSKY, V. N., AND TURK, K. L. The Influence of Tocopherols and Cod Liver Oil on Milk and Fat Procution. *J. Dairy Sci.*, 32: 133. 1949.

THE USE OF ANTHRONE FOR THE QUANTITATIVE ESTIMATION OF LACTOSE IN DAIRY PRODUCTS

H. J. FAGEN, ELIZABETH SIBBACH, AND R. V. HUSSONG
Kraft Foods Company Research Laboratories, Glenview, Illinois

The detection of carbohydrate material by means of anthrone (9-Keto anthracene) was introduced by Dreywood in 1946 *(3)*. Although Dreywood demonstrated the method using synthetic preparations, application to biological materials in more recent years has proved both practical and reliable. Kowald and McCormack *(4)* determined mannose in streptomycin preparations using anthrone. Seifter, *et al. (7)* estimated glycogen in liver with anthrone and reported that any interference due to protein material was well within sampling error and for all practical purposes could be ignored. Shetlar *(8)* applied the anthrone reaction to the determination of carbohydrate material in the presence of serum proteins and studied the effect of many compounds that might interfere with color development. There were no significant side reactions caused by any of the compounds studied, i.e., acetone, pyruvic acid, pyruvic aldehyde, lactic acid, uric acid, ascorbic acid, glutathione, glycylglycylglycine and glycyltyrosine. A quantitative method for the determination of sodium carboxy-methylcellulose in soap and detergent mixtures employing anthrone was presented by Block *(2)*, who indicated that phosphates, silicates, and fatty acids were noninterfering substances.

In view of the evidence indicating that the noncarbohydrate materials in dairy products can be considered as noninterfering with respect to the anthrone reagent, it appeared reasonable that this reaction would afford a rapid, reliable means of determining lactose. It is the purpose of this paper to demonstrate the versatility of the anthrone reagent in the field of dairy chemistry.

EXPERIMENTAL PROCEDURE

Sample preparation. One-tenth to 1 g. of sample was macerated in a Waring blender with 200 ml. of distilled water for 10 minutes. After blending, the mixture was transferred quantitatively to a liter volumetric flask and made up to volume with distilled water.

Reagent. A 0.02% solution of anthrone reagent was prepared by placing 1 g. of anthrone[1] and 50 ml. of distilled water in a 500-ml. volumetric flask and making it to volume with concentrated sulfuric acid. The flask was immersed in an ice bath while the acid was added slowly.

Color development. An aliquot of the sample solution, containing from 10 to 50 gamma of lactose was placed in a 50-ml. Erlenmeyer flask and sufficient distilled water added to a volume of 2.5 ml. The flask was immersed in an ice bath while 10 ml. of the anthrone reagent was added from a burette. The final concen-

Received for publication June 18, 1953.

[1] Microne Brand Anthrone, National Biochemical Co., Chicago.

tration of reagent must be greater than 50% to prevent the formation of a milky suspension due to precipitated anthrone. A slight cloudiness may develop while the solution is very cold; however, it becomes clear after a few minutes at room temperature and in no way affects the determination. The contents of the flask were immediately transferred to a colorimeter tube and placed in a boiling water bath for 5 minutes.

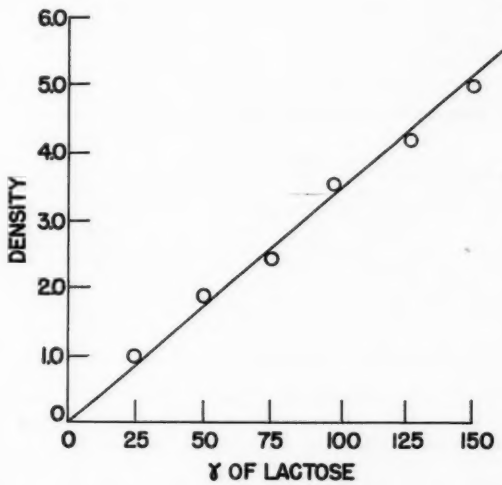


FIG. 1. Standard curve for determining the per cent of lactose by the anthrone method.

Color measurement. Transmittance readings were made with a Lumetron Colorimeter[2] using a 580 filter. The tubes were read immediately after removal from the boiling water bath against a reagent blank, and the quantity of lactose present was determined by referring to the standard curve, Figure 1.

RESULTS AND DISCUSSION

A primary disadvantage in determining lactose in dairy products involves an initial deproteinization of the material under examination. However, with the anthrone reagent, direct analyses can be made on a water solution without interference by protein or fat. Because of the extreme sensitivity of this reagent and the high initial dilution of the sample, turbidity due to fat occasionally encountered in colorimetric methods is eliminated. Table 1 shows comparative data on several types of dairy products run by the A.O.C.S. copper reduction method *(1)* and by employing anthrone reagent. It has been assumed that the lactose was determined at the same stage of hydration in both methods, that is, the monohydrate form. The reproducibility of the anthrone method was found to be good on the dairy products tested; however, differences between the two

[2] Photovolt Corporation, Model No. 401.

TABLE 1

Comparison of the anthrone and copper reduction methods [a]

Product	Anthrone	Copper reduction
	(%)	*(%)*
Whole milk (sample A)	4.86	4.81
Whole milk (sample B)	4.96	4.69
Natural Cheddar (sample A)	0.60	0.56
Natural Cheddar (sample B)	0.59	0.51
Processed cheese (sample A)	7.30	7.12
Processed cheese (sample B)	7.40	7.57
Nonfat dry milk solids (sample A)	55.21	54.18
Nonfat dry milk solids (sample B)	55.78	54.96

[a] All values are the average of duplicate analysis.

TABLE 2

Recovery of lactose added to dairy products by the anthrone colorimetric method

Product	Lactose found	Lactose added	Lactose Recovered	Recovery
	(Mg./g.)	*(Mg./g.)*	*(Mg./g.)*	*(%)*
Whole milk	45	10	54	98
Nonfat dry milk solids	490	200	690	100
Processed cheese	68	60	120	94
Natural Cheddar	10	60	68	97

methods can be explained by the standard deviation of replicate tests. Recovery experiments on cheese, whole milk and nonfat dry milk solids are shown in Table 2. Although these recoveries were made on a variety of products, it should not be assumed that the anthrone method is more applicable to any one product. The results are of limited trials and are not averages obtained for large numbers of samples.

The addition of the anthrone reagent to the water solution is accompanied by the evolution of heat due to hydration of the sulfuric acid. Although the heat of hydration is adequate to initiate the reaction, color produced in this way causes wide discrepancies in the final results *(7)*. Adding the reagent to the water solution in a vessel immersed in an ice bath and subsequent heating produces more uniform color development. The size of the reaction vessel also has a bearing on color development. A 50-ml. Erlenmeyer flask is preferred to a tube because it permits more uniform distribution of the water solution and reagent.

The recommended length of time the sample should remain in the boiling water bath for full color development varies. Morse *(6)* submitted evidence that 95% maximum color development was reached in less than 5 minutes, whereas McCready *(5)* suggested 7.5 minutes. Seifter *et al. (7)* and Shetlar *(8)* recommended 10 minutes and Block *(2)*, 15 minutes. A 5-minute heating period was found adequate to produce a color that remained stable for at least 1 hour. For economy, the anthrone reagent should be prepared in small quantities. In order to achieve maximum stability, the reagent should be prepared a minimum of 4 hours prior to use *(5, 6)*. If excess reagent is stored near 0° C., it can be kept 4 to 5 days *(5, 9)*.

SUMMARY

A sensitive and rapid colorimetric method for determining lactose in dairy products using anthrone reagent has been presented. The proposed method is easily adapted to cheese, whole milk, and nonfat dry milk solids. Because of the high initial dilution of the sample and the extreme sensitivity of anthrone, deproteinization is unnecessary. The recovery ability of the anthrone method is high. Comparative results between the anthrone and the copper reduction methods are in good agreement.

REFERENCES

(1) Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis*, 7th ed. pp. 163, 506-507. 1950.

(2) Block, H. C. Determination of Sodium Carboxymethylcellulose in Detergent Mixtures. *Anal. Chem.*, **23**: 1792. 1951.

(3) Dreywood, Roman. Qualitative Test for Carbohydrate Material. *Ind. Eng. Chem.*, Anal. Ed., **18**: 499. 1946.

(4) Kowald, J. A., and McCormack, R. B. Determination of Mannosidostreptomycin and Dihydromannosidostreptomycin. *Anal. Chem.*, **21**: 1383. 1949.

(5) McCready, R. M., Guggolz, J., Silviera, V., and Owens, H. S. Determination of Starch and Amylose in Vegetables. *Anal. Chem.*, **22**: 1156. 1950.

(6) Morse, E. E. Anthrone in Estimating Low Concentrations of Sucrose. *Anal. Chem.*, **19**: 1012. 1947.

(7) Seifter, S., Dayton, S., Novic, B., and Muntwyler, E. The Estimation of Glycogen with Anthrone Reagent. *Arch. Biochem.*, **25**: 191. 1950.

(8) Shetlar, M. R. Use of Anthrone Reaction for Determination of Carbohydrates in the Presence of Serum Protein. *Anal. Chem.*, **24**: 1844. 1952.

(9) Viles, F. J., and Silverman, L. Determination of Starch and Cellulose with Anthrone. *Anal. Chem.*, **21**: 950. 1949.

MANAGEMENT PRACTICES AND NET RETURNS IN MILK PRODUCTION IN WASHINGTON[1]

E. L. BAUM, C. W. MEY, A. O. SHAW, AND H. G. WALKUP
Departments of Agricultural Economics and Dairy Science
State College of Washington, Pullman

The dairy farmer is being encouraged to spread the milk production of his herd as evenly as possible throughout the year. This is being done through such schemes as seasonal pricing plans, base-quota plans, fall premium pricing plans, and education to even out the freshening schedule of his herd. Dairy plants cannot handle and process this raw product most economically when there is a wide fluctuation in the flow of milk from producers in any given market —high spring and low fall production. Studies have shown that relatively even milk production throughout the year is associated with greater net profits to the dairyman *(5, 7, 8)*. The purpose of the research reported in this paper is to present the relative influence of such factors as date of parturition, inherent productivity of the cow, and feeding practices on dairymen's profit.

RESEARCH PROCEDURES

This study was based on the individual lactation records of cows freshening throughout the year in western Washington—the main dairying area in the state. Most of the analyses were made on an individual cow basis. To set up herds with the desired freshening schedules, statistics for individual cows were compiled to fit these patterns.

Two hundred forty-four individual cow lactation records (DHIA) were sorted into 52 groups on the basis of week of freshening and then into 12 groups representing the calendar months. Next, the percentage of milk produced within each 4-week period was plotted for each group. From this, a lactation curve was drawn representing the average for each of the 12 monthly groups. These curves proved to be similar to those determined from the 28,968 DHIA records from which the sample of records used in this study was taken.

Each lactation period ran 305 days, with a 60-day dry period. The dry period was included because the care of the cow during the latter stages of her gestation has a direct bearing upon the milk production in her next lactation period.

The lactation curves indicated that in Washington fall and winter freshening cows produce more evenly throughout the lactation period than do cows freshening in the spring and summer. Cows freshening from March through July have only one high point in their production peak. In fact, the percentage of a cow's total milk produced during the first 60 days of her lactation increases if she freshens sometime during the period January to July.

Received for publication July 8, 1953.

[1] Scientific Paper No. 1231, Washington Agricultural Experiment Stations, Pullman. Project No. 965 and 1014.

Cows freshening in August and the fall months produce a smaller proportion of their total milk output during the early part of their lactation; also, their lactation curves show a slower rate of decline in production, until the last few weeks of lactation, than do those of cows freshening in any other season.

What effect, if any, does this variation in the lactation curve have on the amount and cost of feed a cow needs? In order to answer this question, the total digestible nutrient requirements for the cows were determined. The TDN in each type of feed basically determines how much of that feed will have to be consumed by a cow if she is to produce a given amount of milk and still maintain her body weight. These requirements were set at 8.61 lb. of TDN daily for body maintenance and 0.324 lb. of TDN for each pound of milk produced, for good cows under usual western Washington conditions.

The cow's TDN needs for her 60-day dry period totaled 774.90 lb., an average of 12.915 lb. a day. This requirement was set 50% higher than normal in order to take care of fetus growth and conditioning. The cow weight was assumed to be 1,100 lb. for the average animal; therefore, the TDN requirements during the dry period were the same for all levels of production. This meant that any variation in costs would be the result primarily of different feeding practices, the season in which the cow was not in milk, and the seasonal variation in prices.

Four feeding schedules were set up and studied at all levels of production and for each month of freshening. These schedules were based on varying amounts of hay and silage, supplemented with available pasture, and a 16% total crude protein commercial dairy ration when these feeds did not supply the required TDN (Table 2). The amount of grain fed per day varied because it was used as a residual feed. On the average, the daily amount of TDN that the cows received from pasture varied *(3)* from month to month (Table 1).

TABLE 1

Average amounts of TDN secured from pasture per cow, for each month of the pasture season

Month	Days on pasture	TDN secured daily from pasture[a]	TDN secured during month from pasture
		(lb.)	*(lb.)*
April	15	13.00	195.0
May	31	16.00	496.0
June	30	13.00	390.0
July	31	10.00	310.0
August	31	8.61	266 9
September	30	10.00	300.0
October	10	8.61	86.1
Total	178		2,044.0

[a] These yields do not assume irrigated pasture but are average for western Washington pastures under normal weather conditions *(3)*. From July 16 to August 31, enough hay was fed as a supplement to pasture to bring the daily source of TDN to 12 lb.

Frequent wet weather makes it difficult to produce good quality hay in western Washington. A mixed clover and grass hay which averages about 43% TDN is commonly fed *(2)*. Grass silage was calculated at 17% TDN *(4)*. Other

kinds of silage are used in western Washington, but grass silage is becoming more practical and most popular.

Feeding schedules. The timing and the amounts of feed fed under the four schedules, computed on TDN content and requirements, are presented in Tables 2 and 3. A transition period between pasture and barn feeding was provided, during which both hay and silage were fed in smaller amounts than during the regular barn feeding season. The spring transition period was from April 16 through April 30; fall transition was from September 15 through October 10.

TABLE 2

Quantities of feed fed daily in each feeding schedule

Type of feed	Barn period	Pasture period	Barn period	Pasture period
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*
	Feeding schedule 1		Feeding schedule 2	
Hay	15	7.5—spring transition period 7.0—fall transition period		10.0—spring transition period 6.3—fall transition period
		Supplement to pasture	30	Supplement to pasture
Silage	40	None	None	None
Pasture	None	Varied	None	Varied
Grain	Varied	Varied	Varied	Varied
	Feeding schedule 3		Feeding schedule 4	
Hay	5	Supplement to pasture July 16-August 30	20	6.3—fall transition period 5.0—spring transition period Supplement to pasture
Silage	80	20.0—spring transition period 35.2—fall transition period	None	None
Pasture	None	Varied	None	Varied
Grain	Varied	Varied	Varied	Varied

TABLE 3

Amounts of each feed fed and amounts of TDN secured from each feeding schedule, excluding grain

Type of feed	Total fed	TDN secured	Total fed	TDN secured
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*
	Feeding schedule 1		Feeding schedule 2	
Hay	3,100	1,333.00	5,924	2,547.23
Silage	7,280	1,237.60	None	None
Pasture	(178)	2,044.01	(178)	2,044.01
Total		4,614.61		4,591.33
	Feeding schedule 3		Feeding schedule 4	
Hay	935	402.05	4,298	1,848.14
Silage	16,175	2,749.75	None	None
Pasture	(178)	2,044.01	(178)	2,044.01
Total		5,195.81		3,892.15

Pasture costs. Pasture was priced the same as if the land had been in hay. Thus, with an average yield at 3.65 T. per acre *(6)* and sale price of $20.66 a ton, the following formula was used:

$$\frac{\$75.41 \text{ (average return per acre of hay)} - \$10.43 \text{ (harvesting cost at } \$3.50 \text{ per T. of hay)}}{4{,}136 \text{ [lb. of TDN secured from an acre of pasture } (2)\text{]}} = \frac{\$64.98}{4{,}136}$$

$$= \$0.0157 \text{ (cost per lb. TDN)}$$

During May, for example, when pasture was lush, an average 1,100-lb. cow secures about 16 lb. of TDN a day from pasture *(3)*. This figure times $0.0157 yields a cost of $0.25 a day. In August, a poor pasture month, cows will secure on the average about 8.63 lb. of TDN each a day *(3)*—8.63 × $0.0157 amounts to $0.14 a day.

Silage costs. Silage also was priced as if the land had been in hay. Grass silage yields run about 10 T. per acre, and aftermath pasture amounts to approximately 3 T *(6)*. A charge of $2.77 per ton for harvesting costs was added, since silage harvesting is costlier than that for hay. The cost per pound TDN secured from silage was figured in the following manner:

$$\frac{\$64.98 \text{ (net return per acre of hay)} + \$27.70 \text{ (labor and harvest cost)}}{4.420 \text{ (lb. TDN secured from an acre of silage)}} = \frac{\$92.68}{4{,}420}$$

$$= \$0.02097 \text{ (cost per lb. TDN)}$$

Thus a 17% TDN grass silage was priced at $7.13 per ton, or $0.00356 per pound.

Grain and hay costs. Average monthly prices for the 16% total crude protein commercial dairy ration were used as a basis for grain costs. Since TDN requirements were figured in 4-week periods and the schedules were set up accordingly, there was some overlapping. For example, a 4-week period starting on March 24 has 6 days of grain consumption at March prices and 22 days at April prices. The amount of grain fed varied with the amount of TDN provided by the other forms of feed.

The value of hay consumed was handled the same way as that of grain consumed. It was assumed that all hay fed was eate. which may give a slight error, since no credit was allowed for hay refused but used for bedding or feed for young stock.

Miscellaneous costs and returns. Certain other costs and returns were included to make the calculations as realistic as possible, even though in practice there might be no actual cash return from them. An allowance of $15.00 was made for each calf sold at birth for vealing. If calves are kept for herd replacement, then a greater allowance would have to be made for calves from inherently higher milk producing cows.

A yearly credit of $14.00 per mature animal was made on the basis of 7 T. of manure at $2.00 per ton *(4)*. Milk fed and used in the home was not included because the returns from milk are based on total milk production, not on the

distribution and use of the milk. Although under actual conditions, depreciation and/or appreciation would have to be considered, depending mainly on the age of the cow, this type of allowance was not included in this study.

Feed and labor are the major costs of milk production. However, there are many other costs, such as housing, milking equipment, breeding fees, bedding, veterinary services, whitewash, disinfectants, and milk hauling. With the exception of the fee for hauling, these miscellaneous costs for each cow are constant for each feeding schedule within a level of production. These costs totaled $58.80 per cow, distributed as follows:

Building costs	$25.60
Equipment	7.20
Breeding costs or fees	6.00
Miscellaneous	20.00
	$58.80

The total cost of milk hauling depends on the total herd production and the local hauling rate structure. The other miscellaneous costs are the same for all levels of production. Thus, the differences in milk hauling fee make the difference in the total miscellaneous costs listed below:

Level of milk production	*Total miscellaneous costs*
6,000 lb.	$72.60
7,000 "	74.90
8,000 "	77.20
9,000 "	79.50
10,000 "	81.80

DISCUSSION

Feed cost variations. Pasture and silage costs are constant for the year. The amount of pasture available does vary from month to month, but the amount and quality available for the year were treated as a constant. In the selected feeding schedules, the price of silage was constant throughout the barn feeding period. The varying amounts of it fed under the four schedules make a difference in the total cost of feeding. The amount fed changes with the seasonal supply and price of grain and hay which could be used in various combinations with silage. Actually, for practical management reasons, dairymen do not vary feeding practices very much. Thus, the computations can logically be made on an annual basis.

The total feed cost varies with the month of freshening (Table 4). Cows freshening in the fall generally had the lowest total feed costs under these feeding practices. Cows freshening in June and July exhibited the highest costs except for those fed Schedule 3—the heavy silage ration. For that schedule, cows freshening in February and March had the highest annual costs, because these cows of a given level of production were overfed the greatest amount of TDN.

Annual pasture and silage costs for each of the four feeding schedules were the same. Since the schedules varied in the amount of TDN available from roughages and succulent feeds, the differences were made up in varying amounts of grain. Thus the cost differences among schedules and freshening months within a given schedule resulted from the amount of hay and grain fed.

TABLE 4

Value of grain and total feed fed per year, per cow, for an average dairy cow producing 8,000 lb. of 4% milk with different months of freshening, using four feeding schedules

Month of freshening	Schedule 1		Schedule 2		Schedule 3		Schedule 4	
	Grain	All feed	Grain	All feed	Grain	All feed	Grain	All feed
	($)	*($)*	*($)*	*($)*	*($)*	*($)*	*($)*	*($)*
Jan.	69.03	162.09	69.36	166.18	48.71	150.89	111.15	187.57
Feb.	69.32	162.29	70.07	166.70	56.54	158.70	110.75	187.12
Mar.	69.92	162.63	69.52	165.64	56.28	158.35	109.85	184.87
Apr.	68.06	160.89	68.19	164.51	51.78	153.88	108.76	184.88
May	69.79	162.38	71.21	167.11	53.65	155.69	108.11	183.95
June	72.85	165.45	75.19	171.11	53.34	155.39	111.06	186.89
July	72.06	164.67	73.27	169.20	51.03	153.08	112.05	187.87
Aug.	66.05	158.75	67.74	163.76	39.29	141.42	107.31	183.18
Sept.	65.81	158.86	66.95	162.76	38.15	140.68	105.45	181.82
Oct.	65.84	159.15	66.85	163.51	37.75	140.28	107.31	183.85
Nov.	66.16	160.07	67.23	164.90	42.27	144.95	107.66	184.79
Dec.	66.69	161.42	64.26	163.62	47.50	150.47	108.26	186.59

Feeding Schedule 4—the high grain, no silage diet —cost the most for all months of freshening. Schedule 2—the equal hay-grain, no silage diet—was the next highest in cost. Lowest costs were those for Schedule 3, which featured large amounts of silage and relatively small amounts of hay, supplemented with grain and pasture.

For a cow freshening in August, the choice of feeding schedule does not make too much difference. Only for a short period near the end of her lactation period will the cow receive more pounds of TDN from roughage and succulent feeds than she requires, no matter what schedule she follows.

A cow freshening in March consumes more than is necessary from about the 36th week of lactation on through her gestation period. This overfeeding increases the animal's feed costs and decreases net returns. Schedules 1 and 2 come closer to providing what she requires, although at times even these provide more than is necessary. Schedule 4 yields decreasing amounts of TDN from about the 32nd week to the end of gestation. The difference between the TDN furnished then and what the cow needs must be made up by grain during her dry period. At this time the cow needs about 5 lb. of grain to make up her deficit under Schedule 4. Were the cow on Schedule 3, at this same time she would be getting about 4 lb. of TDN more than necessary.

Milk production returns. The returns from milk production are governed strongly by the month the cow freshens and by the seasonal price of milk. Milk prices are usually lowest in the spring and highest during the fall and early winter months. It is impotrant, then, to have cows producing the greatest

quantity of their milk at the time when milk prices are highest— and if possible at the same time when feed costs are the lowest.

In accordance with milk prices in western Washington during 1949 and 1950, the most profitable months for parturition were August and September. This was measured in net returns to labor and management, for each of the four feeding schedules, and is shown in Table 5.

TABLE 5

Net returns to labor and management for individual cows producing 8,000 lb. of milk, by month of freshening and feeding schedule

Month	Schedule 1	Schedule 2	Schedule 3	Schedule 4
	($)	*($)*	*($)*	*($)*
Jan.	108.16	104.07	119.36	82.68
Feb.	99.70	95.29	103.29	74.87
Mar.	92.81	89.80	97.09	69.57
Apr.	93.98	90.36	110.27	69.99
May	95.14	90.41	101.83	73.57
June	97.23	91.57	107.29	75.79
July	102.93	98.40	114.52	79.73
Aug.	110.79	105.78	128.12	86.35
Sept.	109.13	105.23	127.31	86.17
Oct.	105.98	101.62	124.85	81.28
Nov.	101.13	96.30	116.25	76.41
Dec.	94.47	92.27	105.42	69.30

The reason August and September freshening cows yielded the largest net return is that their milk production schedule follows closely the schedule of fluid milk prices. These cows begin to produce milk soon after milk prices start to rise from their seasonal low, and their peak daily milk production is reached just before the season of highest milk prices. Cows freshening during these months produce the greatest amount of milk during the time when fluid milk prices are highest.

The feed cost pattern for the time period studied also fits well with the production schedule of cows freshening in August and September. Grain was used to supplement the TDN furnished by the other feeds. Grain prices were lowest during August 1949 and increased only slowly throughout the lactation periods of these cows. Thus, when the most grain was needed, its price was lowest.

In general, cows freshening in March and April exhibited opposite relationships. They produced the most milk when fluid milk prices were lowest and the least when prices were highest; they needed the most grain supplement when grain prices were highest and the least when grain was the cheapest.

The level of milk production per cow did not change the relationships cited above, regardless of feeding schedule followed. Cows freshening in the fall still yielded the greatest net returns, and cows freshening in the spring returned the least.

The range of variation in net returns between months of freshening was fairly narrow except for Feeding Schedule 3—the heavy silage diet. Under this schedule, average annual net returns per hundredweight of milk for cows producing 6,000 lb. of 4% milk varied from $0.87 for cows freshening in April 1949

to $1.29 for cows freshening in October 1949—a difference of $0.42 a hundredweight. However, even for Schedule 3, the higher producing cows exhibited less spread between least profitable and most profitable month of freshening. For a cow producing 10,000 lb. of 4% milk, returns varied from $1.39 to $1.71—a difference of $0.32 a hundredweight.

Generally, Schedules 2 and 4 did not have such wide spreads, as they were primarily hay and grain rations. Cows fed under these feeding schedules averaged a return spread between least and most profitable months of $0.20 per hundredweight of milk.

SUMMARY

Under milk-feed ratios similar to those that existed during 1949 and 1950 in western Washington, the practice of heavy grain feeding combined with a fair amount of hay (Feeding Schedule 4) incurs the highest cost per cow or per hundredweight of milk, regardless of month of freshening or level of production. The practice of feeding large amounts of grass silage, such as under Schedule 3, provides the cheapest supply of TDN for any month of freshening.

Differences in total costs for cows freshening in the same month, but fed under different schedules, appear to be influenced more by the amounts of concentrates fed than by the amounts of roughage and succulent feeds consumed. This infers that when the milk-grain ratio is unfavorable, the differences between costs of different types of feeding schedules will become more apparent.

The level of milk production per cow changes only the magnitude of net returns per cow. The level of production does not change the relationship between the most profitable and the least profitable month of freshening.

REFERENCES

(1) Baum, E. L., and Jorgenson, R. E. Some Economic Aspects of Milk Production and Pricing. Wash. Agr. Expt. Sta., *Circ.* 127. 1950.

(2) Hodgson, R. E., Knott, J. C., Miller, V. L., and Maurer, H. K. The Nutritive Value of Home Grown Roughage Rations for Dairy Cattle. Wash. Agr. Expt. Sta., *Bull* 366. 1938.

(3) Knott, J. C., Hodgson, R. E., and Ellington, E. V. Methods of Measuring Pasture Yields with Dairy Cattle. Wash. Agr. Expt. Sta., *Bull.* 295. 1934.

(4) Morrison, F. B. *Feeds and Feeding.* Morrison Publishing Co. Ithaca, N. Y. pp. 417, 1147. 1948.

(5) Northeast Agricultural Experiment Stations. Factors Affecting Seasonal Milk Production and their Effect on Producers' Cost and Returns. Me. Agr. Expt. Sta., *Bull.* 459. 1948.

(6) Stippler, H. H., Buchanan, M. T., and Law, A. G. Methods of Harvesting Hay Fields in Northwestern Washington (North Coast Area). Wash. Agr. Expt. Sta., *Bull.* 502. 1948.

(7) Wilcox, R. H., and Rhode, C. S. Cost of Producing Milk in Northern Illinois. Ill. Agr. Expt. Sta., *Bull.* 511. 1945.

(8) Wilcox, R. H., and Rhode, C. S. Cost of Producing Milk in Illinois Portion of the St. Louis Milkshed. Ill. Agr. Expt. Sta., *Bull.* 515. 1945.

RELATIONSHIP BETWEEN TITRATABLE ACIDITY AND pH DURING LACTIC ACID FERMENTATION IN RECONSTITUTED NONFAT MILK[1]

H. H. WILKOWSKE

Department of Dairy Science
Florida Agricultural Experiment Station, Gainesville

Large quantities of skimmilk are used in the manufacture of cottage cheese and cultured buttermilk. The supply of fresh skimmilk has been insufficient to meet increasing consumer demands for these fermented dairy products. While fresh skimmilk and condensed skimmilk are available primarily during surplus periods in some sections, nonfat dry milk is available throughout the year.

Because of its good keeping quality and ease of storage, nonfat dry milk is being used in greater quantity each year by the dairy industry for the manufacture of various dairy products. To increase the volume and yield, cottage cheese may be manufactured from fresh skimmilk in which the solids content has been increased by addition of nonfat dry milk solids or condensed skimmilk *(1, 2, 3, 4, 6, 8, 10, 19, 20)*. Cultured buttermilk may be manufactured by fortifying fresh skimmilk with additional solids *(1, 3, 7, 9, 17)*. Also, cottage cheese and cultured buttermilk of excellent quality may be made by using reconstituted products exclusively *(1, 2, 3, 4, 8, 10, 11, 13, 15, 18)*. Cottage cheese may be made from reconstituted products ranging in solids content from 9 to 20%, the latter suggested by Reid and Maughan *(15)*. For making cultured buttermilk when using reconstituted nonfat milk exclusively, or when fortifying fresh skimmilk, 10 to 11% solids content generally has been recommended.

Milk solids are known to produce an "apparent acidity" when measured by titration with a solution of sodium hydroxide. When fresh skimmilk is fortified with additional solids, the product exhibits an increase in apparent acidity. Also, the apparent acidity of reconstituted nonfat milk increases with increases in percentage of solids.

It appeared that variations in the percentage of solids might influence the titratable acidity values obtained during the lactic acid fermentation process. The purpose of this study was to obtain information concerning the relationship between titratable acidity and pH during lactic acid fermentation in reconstituted nonfat milk varying in concentration from 9 to 20% solids.

EXPERIMENTAL

Several different commercial brands of "low-heat," spray dried, nonfat dry milk solids were used. The nonfat dry milk was reconstituted on a weight basis, assuming an average total solids content of 97%. Laboratory trials were made using 500-g. samples inoculated with commercial buttermilk cultures or cheese starters. The cultured buttermilk trials consisted of a 1% inoculation

Received for publication July 9, 1953.

[1] Florida Agricultural Experiment Station, Journal Series No. 174.

and incubation at 70° F. Cottage cheese was manufactured using the short-time method, employing 5% starter and 90° F. setting temperature. Acidity measurements of the reconstituted products and whey were made during fermentation using 18-g. samples and ½ ml. phenolphthalein indicator and titrating with $N/10$ sodium hydroxide. The pH determinations were made using the glass electrode method.

In some laboratory trials, rennet was added to obtain whey in samples where insufficient acid had developed to form an acid curd suitable for filtration. This usually was necessary above approximately pH 5.0. Whey samples were obtained by gravity filtration through coarse filter paper. Some trials consisted of adding known amounts of chemically pure, concentrated lactic acid in lieu of fermentation to determine the relationship between titratable acidity and actual amount of lactic acid present. This procedure was necessary, since Schock and Breazeale *(17)* reported that the rate of acid development increases with an increase in the concentration of skimmilk solids and that fermentation during a specified period of time in skimmilk of different solids concentration does not result in the development of equal concentrations of lactic acid.

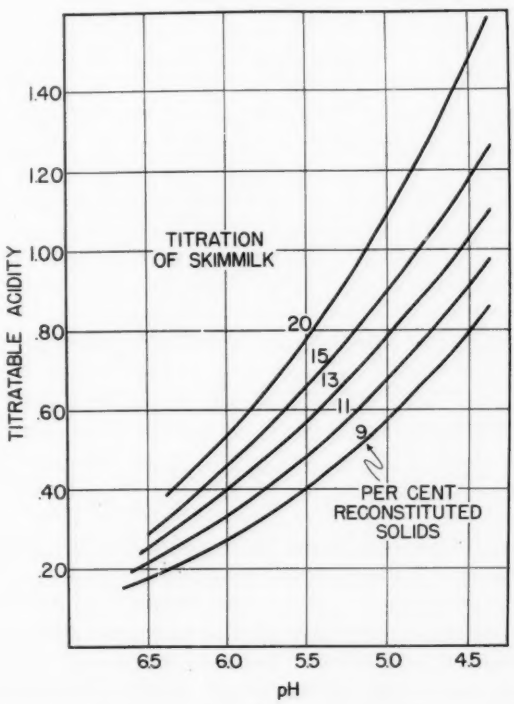


FIG. 1. The relationship of titratable acidity and pH in reconstituted nonfat milk of various concentrations.

RESULTS AND DISCUSSION

The results obtained are presented in graphic form representing average values of three trials for each solids concentration. Figure 1 shows the titratable acidity values at various pH levels for reconstituted products of concentrations between 9 and 20% solids. Figure 2 shows the corresponding values for whey obtained from the reconstituted products.

It was found (Figure 1) that the initial titratable acidity in 9% reconstituted nonfat milk was 0.16% at pH 6.6. The titratable acidity of the 20% product was 0.38% at pH 6.4. With increasing solids concentration from 9 to 20%, there was an increase in the initial or apparent acidity of 0.02 for each 1% increase in solids with only a slight lowering of pH.

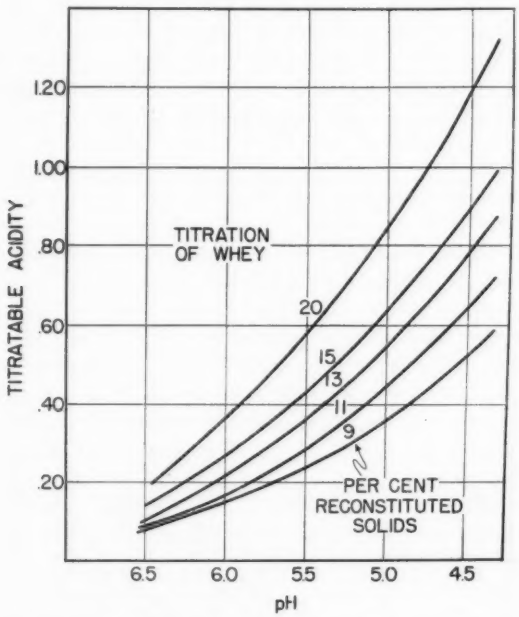


FIG. 2. The relationship of titratable acidity and pH of whey from reconstituted nonfat milk of various concentrations.

During lactic acid fermentation in the manufacture of cultured buttermilk, proportionately greater increases were found in titratable acidity values for each additional 1% increase in solids concentration. At pH 4.6 reconstituted skimmilk of 9% solids content produced a titratable acidity of 0.76%, and the 11% solids skimmilk titrated 0.88%. This was an increase of 0.06% titratable acidity for each 1% increase in solids. When the titratable acidities of cultured buttermilk containing 9 and 11% solids were both 0.76%, the latter was almost 0.25 unit less in pH. This resulted in less acid flavor in cultured buttermilk.

With an increase in solids concentration, a greater amount of lactic acid was required to lower the acidity to the same pH level as indicated by greater titratable acidity during the fermentation process. Buttermilk manufactured using 11% reconstituted solids should titrate 0.12% more than when 9% solids skimmilk is used. When higher solids concentrations are used in cultured buttermilk manufacture, greater titratable acidities are needed to lower the pH to levels favorable for aroma-producing microorganisms to produce the characteristic flavors and aromas. According to Michaelian *et al. (12)* maximum yields of acetylmethylcarbinol plus diacetyl are obtained at pH values from 4.4 to 4.1.

Costilow *et al. (9)* found that buttermilk of 10% solids was the most desirable from the standpoint of both body and flavor. They believe a satisfactory acidity range is from 0.85 to 0.90%. According to Figure 1, this would result in a pH of 4.55 to 4.45. Schock and Breazeale *(17)* recommend 10% solids concentration and fermentation to titratable acidities of 0.92 to 1.03% in cultured buttermilk. This would be pH 4.4 to 4.25, according to Figure 1.

Figure 2 shows the relationship of titratable acidity and pH of whey. The coagulation was the result of rennet action, added lactic acid, or lactic acid fermentation. During these studies several hundred pH determinations were made on samples of coagulated skimmilk before and after filtration. In all trials the pH of the curd and that of whey of the same sample were practically identical, confirming earlier observations of Price *(14)*.

Brown and Price *(5)* presented data showing the relation between the pH and titratable acidity of whey as encountered in Cheddar cheese manufacture when using whole milk. At lower titratable acidity values the pH values were in agreement with the 9% solids curve of Figure 2. Their data showed that as the titratable acidity increased from 0.45 to 0.70% the pH decreased from 5.4 to 5.2, whereas Figure 2 would show a decrease to pH 4.3. They pointed out that the titratable acidity-pH relationship is not constant under all conditions and might be influenced by such factors as types of organism, initial apparent acidity, and buffer capacities. Apparently similar conditions do not exist in whey from rennet coagulation of whole milk as encountered in the Cheddar cheese making procedure and the whey from acid coagulation of reconstituted nonfat milk.

In cottage cheese manufacture, titrations of the clear whey are widely used as a guide in determining the progress of coagulation and curd formation. When large variations are made in the initial percentage of solids, there is greater difficulty in selecting the proper titratable acidity for cutting the curd. Tuckey *(19)* has pointed out that "at the same pH value, the titratable acidity of the whey from high solids milk will be greater than that from low solids milk. Hence, the correct acidity for cutting cottage cheese curd depends on the composition of the milk from which the cheese is made."

Several investigators *(6, 10, 19)* have shown the importance of permitting sufficient lactic acid development to lower the pH to near 4.6, which is optimum for skimmilk coagulation. Figure 2 shows that at pH 4.6 there was an increase in the titratable acidity of the whey in direct proportion to the increase in the original solids concentration. The whey from nonfat milk containing 9% solids

produced a titratable acidity of 0.49, whereas the whey from the 20% product titrated 1.15%, an increase of 0.06% titratable acidity for each 1% increase in the solids concentration of the reconstituted products from which the whey was obtained. At pH 4.6 both the skimmilk (Figure 1) and whey (Figure 2) showed a similar 0.06% titratable acidity increase for each 1% increase in solids concentration.

Several investigators have observed increases in titratable acidities of whey at pH 4.6 due to increased solids concentrations. Hales *(10)*, quoting unpublished data of F. J. Babel, reported an average increase of approximately 0.066% in the titration of the clear whey at pH 4.6 with each increase of 1% in solids of the reconstituted skimmilks between 9.53% and 11.08% solids. There was an increase of 0.10% in the titration of the clear whey for each 1% increase in solids in various fresh skimmilk samples obtained from different breeds of dairy cattle ranging from 8.64 to 10.21% solids. Tuckey *(19)* reported whey titratable acidity increase of approximately 0.12% at pH 4.6 for each 1% increase in solids of fresh skimmilk from various breeds ranging in solids content from 8.40 to 9.81%.

Recognition of the influence of added solids on the titratable acidity of whey at the lower pH levels has prompted several recommendations for determining the proper cutting acidity in cottage cheese manufacture. Rosenberger *(16)* suggests that for each 1% solids increase the curd should be cut at 0.05% higher acidity. The American Dry Milk Institute *(1)* has suggested that the whey acidity in cottage cheese manufacture should be 0.34 to 0.36% greater than the initial titratable acidity. According to Figure 1, this would represent an allowance of 0.02% increase in titratable acidity for each 1% solids increase. Angevine *(3)* has suggested that in selecting the proper cutting acidity "an allowance of approximately 0.02% titration up or down for each 1% change in solids of skimmilk should be made." A practical application of this has been made by Angevine in the form of a useful chart[2] showing recommended cutting acidities for reconstituted and fortified skimmilk of various solids concentrations.

Much of the published literature on cottage cheese manufacturing, especially that made from fresh skimmilk, does not contain complete information in respect to percentage of solids, pH, and titratable acidity found suitable for cutting the curd. However, when any two of the three factors are given, the third may be estimated by use of Figure 2. To illustrate, and for comparison, the published data of several leading cottage cheese researchers has been tabulated in Table 1, including an estimate of the pH according to Figure 2.

It appears that differences in pH occur under varying conditions of manufacture using different titratable acidities and percentage solids composition, all of which apparently result in satisfactory cottage cheese. An allowance of greater than 0.02% increase in titratable acidity for each 1% increase in solids should be made in selecting the proper cutting acidity, but to avoid excessive acid development not as much as 0.06% should be allowed.

[2] Kontrol-A-Graf chart, copyright 1952, Meyer-Blanke Co., St. Louis, Mo.

TABLE 1

Summary of various suggested solids concentrations and titratable acidities for cutting curd in cottage cheese manufacture, with estimate of pH based upon curves shown in Figure 2

Reference	Solids[a]	Titratable acidity	Estimated pH
	(%)	*(%)*	
(1) American Dry Milk Institute	11.5	0.56-0.58[b]	4.75-4.7
(4) Angevine	9	0.52	4.5
	13	0.60	4.9
(6) Collins	12	0.70	4.5 (4.80)[c]
	15	0.80	4.7 (4.85)
	18	0.90	4.8 (4.90)
(8) Cordes	13	0.58-0.62	4.9-4.85
(10) Hales, quoting Babel	9.53	0.50	4.55
	10.06	0.53	4.6
	10.43	0.57	4.6
	11.08	0.60	4.65
(11) Hales	10	0.52	4.65
	12	0.56	4.8
(15) Reid and Maughan	20	0.60-0.90	5.4-4.9
(18) Stiles	11	0.48-0.50	4.9-4.8
(19) Tuckey	10.20	0.58	4.6 (4.60)[c]
	11.20	0.62	4.65 (4.60)
	11.20	0.56	4.8 (4.62)
	11.30	0.59	4.7 (4.60)

[a] Reconstituted on weight basis assuming 100% total solids in the nonfat dry milk solids.

[b] Initial acidity estimated from Fig. 1 to be 0.22 plus recommended 0.34 to 0.36% increase in acid development.

[c] pH reported by authors given in parentheses.

Collins *(6)* pointed out that in high solids skimmilk (15 to 18%) the pH decreases slowly below pH 5.0 and adequate firmness for cutting was reached with less reduction of pH and at higher titratable acidity values as the per cent of milk solids was increased. He stated that the effect of added solids on the rate of increase in titratable acidity of whey was less significant than was the effect of pH.

The subsequent acid development after cutting will depend upon length of time allowed for curd to settle and length of time required to inactivate the acid-producing organisms at the cooking temperature used. The manufacture of cottage cheese from nonfat dry milk of 13% solids results in slightly firmer coagulation than that from dry milk of 9% solids at the same pH level. The amount of coagulating agent used, if any, also would influence the firmness of the curd. Satisfactory results were obtained by cutting cheese made from milk of 13% solids at pH 4.8, using the corresponding titratable acidity value for whey shown in Figure 2 of 0.62% and permitting additional acid development to reach a final pH of 4.7 to 4.6.

SUMMARY

Titratable acidity and pH measurements were made during lactic acid fermentation in reconstituted nonfat milk ranging from 9 to 20% solids. Measurements were made on the reconstituted products and also on the corresponding whey obtained therefrom. The results, which are presented in graphic form, show the relationship of the titratable acidity, pH, and solids concentration during fermentation down to pH 4.4.

Before fermentation, an initial apparent acidity of 0.16% in nonfat milk containing 9% solids increased 0.02% acidity for each additional 1% increase in solids reconstituted, accompanied by a slight decrease in pH from 6.6 to 6.4. During lactic acid fermentation proportionately greater increases in titratable acidities of both the reconstituted products and whey were observed for each additional 1% solids increase. At pH 4.6 both the reconstituted solids and whey showed a 0.06% increase in titratable acidity for each 1% increase in the original solids concentration.

Good quality cultured buttermilk was obtained, using reconstituted nonfat milk containing 11% solids and developing the titratable acidity to 0.90-0.95% at pH 4.5 to 4.4.

Using the short-time method, satisfactory cottage cheese was obtained using nonfat milk containing 13% solids, cutting the curd at a clear whey titratable acidity of 0.62% at approximately pH 4.8, and permitting additional acid development to a final pH of 4.7 to 4.6.

REFERENCES

(1) American Dry Milk Institute. Nonfat Dry Milk Solids in Dairy Manufacturing. *Bull.* 650. 1951.

(2) Angevine, N. C. Improved Sweet Curd Cottage Cheese. Meyer-Blanke Company, *Bull.*, Revised Sept. 1950.

(3) Angevine, N. C. High Quality Cottage Cheese and Cultured Milk Products. *Southern Dairy Products J.*, **50** (6): 50. 1951. Also, *Can. Dairy and Ice Cream J.*, **31** (5): 34. 1952.

(4) Angevine, N. C. The Manufacture of Quality Cottage Cheese in 1953. *Milk Plant Monthly*, **42** (2): 32. 1953.

(5) Brown, L. W., and Price, W. V. A Study of the Relationship Between Hydrogen Ion Concentration, Titratable Acidity and Quality in Cheddar Cheese. *J. Dairy Sci.*, **17**: 33. 1934.

(6) Collins, E. B. Cottage Cheese from Skim Milk Supplemented with Condensed Skim and Nonfat Dry Milk Solids. *Milk Dealer*, **40** (7): 41. 1951.

(7) Cordes, W. A. Guide for the Processing and Handling of Cultured Buttermilk. National Dairy Products Corp., *Mimeo. Manual.* May 1, 1952.

(8) Cordes, W. A. Procedures for Making Cottage Cheese from Low-Heat Non-Fat Dry Milk Solids (Spray Process). *Mimeo. Rpt. Rev.* Jan. 26, 1953.

(9) Costilow, R. N., Speck, M. L., and Roberts, W. M. The Manufacture of Cultured Buttermilk from Non-Fat Dry Milk Solids. *Milk Plant Monthly*, **38** (4): 36. 1949.

(10) Hales, M. W. *Sweet Curd Cottage Cheese.* Chr. Hansen Lab., 2nd ed. 1950.

(11) Hales, M. W. Cottage Cheese from Reconstituted Nonfat Dry Milk Solids. *Butter, Cheese Milk Products J.*, **43** (6): 22. 1952.

(12) MICHAELIAN, M. B., HOECKER, W. H., AND HAMMER, B. W. Effect of pH on the Production of Acetylmethylcarbinol plus Diacetyl in Milk by the Citric Acid Fermenting Streptococci. *J. Dairy Sci.*, 21: 213. 1938.

(13) PARMALEE, C. B., AND ROSENBERGER, W. S. Procedure for Making Cottage Cheese from Special Low Heat Treatment Non-Fat Dry Milk Solids. Iowa State College, *Mimeo. Ept.* S-521 Miscl. Not dated.

(14) PRICE, W. V. Shortening the Method of Making Cottage Cheese. *Proc. 25th Ann. Conv.*, Intern. Assoc. Milk Dealers, Detroit, Mich., pp. 35-45. Oct. 17-19, 1932.

(15) REID, W. H. E., AND MAUGHAN, M. O. Manufacture of Cottage Cheese from Nonfat Dry Milk Solids. Mo. Agr. Expt. Sta., *Bull.* 505. 1947.

(16) ROSENBERGER, W. S. Personal communication.

(17) SCHOCK, A. A., AND BREAZEALE, D. F. Cultured Buttermilk from Non-Fat Dry Milk Solids. S. D. Agr. Expt. Sta., *Bull.* 391. 1948.

(18) STILES, J. C. Use of Nonfat Dry Milk Solids in the Making of Cottage Cheese and Cultured Buttermilk. *Milk Dealer*, 39 (8): 132. 1950.

(19) TUCKEY, S. L. Problems in the Production of Cottage Cheese. *Milk Dealer*, 40 (6): 46. 1951.

(20) TUCKEY, S. L. Timely Tips for Cottage Cheese Production. Plant Sec. *Proc. 45th Ann. Conv.*, Milk Industry Fdn., pp 1-9. 1952.

BLOOD STUDIES OF BREEDING DAIRY BULLS. I. HEMATOCRIT, HEMOGLOBIN, PLASMA CALCIUM, PLASMA INORGANIC PHOSPHORUS, ALKALINE PHOSPHATASE VALUES, ERYTHROCYTE COUNT, AND LEUCOCYTE COUNT

L. L. RUSOFF, J. E. JOHNSTON, AND CECIL BRANTON
Dairy Department
Louisiana Agricultural Experiment Station
Baton Rouge

There is a voluminous literature on blood studies of dairy cows. The effect of such factors as breed, age, ration fed, stage of lactation, stage of gestation, season, and environmental temperatures have been investigated in their relationship to "normal" values of various blood constituents.

Very few blood analyses of healthy dairy bulls are available, and, in general, only one or two blood constituents representing analyses done only once with a relatively small number of animals have been reported *(1, 3, 5, 7, 9)*. One extensive study has been made on the blood composition of young Holstein breeding bulls *(11)*. Dimick and Thompson *(5)* in 1906 reported hemoglobin, erythrocyte, and leucocyte counts on one Holstein, one Jersey, and one Guernsey bull. Hemoglobin values were 65, 60, and 60%; erythrocyte counts, 6,676,000, 4,818,000, and 5,920,000 per cubic millimeter; and leucocyte counts, 4,400, 3,555, and 5,350 per cubic millimeter, respectively. In 1930, Anderson *et al. (1)* reported average values of 13.40 mg.% for plasma Ca, 3.34 mg.% for inorganic P and 86.8% for hemoglobin of young dairy bulls of mixed breeds from birth to 10 months of age. Duplicate analyses were made on approximately 15 animals. McCay *(9)* in 1931 made 70 determinations of hemoglobin values on six mature bulls of four different breeds and reported an average of 12.8 g.%. He reported that his data indicated a slight rise during the summer months. Brooks and Hughes *(3)* in 1932 reported an average hemoglobin value of 11.92 g.% for 24 bulls of all breeds over 9 months of age. Only one sample was obtained from each bull. Four Holstein bulls in one herd averaged 12.99 g.% and nine Holstein bulls in another herd 10.61 g.%; four Guernsey bulls, 10.80 g.%; and eight bulls representing Holstein, Ayrshire, Guernsey, and Jersey breeds, 12.93 g.%. In 1937, Hamersma *(7)* made monthly blood analyses on two oxen, 25-27 months of age, for hemoglobin, plasma Ca, and plasma inorganic P for one year. The hemoglobin values ranged from 9.94 to 14.55 g.%, plasma Ca from 9.2 to 13.7 mg.%, and inorganic P from 6.06 to 9.10 mg. %, over a 12-month period. No significant variation between monthly averages was found. Standards for blood composition of young healthy Holstein bulls were reported by Reid *et al. (10, 11)* in 1948. These investigators presented data at 3-month intervals on hemoglobin, packed red blood cells, erythrocyte count, plasma Ca, plasma inorganic P, and alkaline phosphatase values of 12 healthy Holstein bulls, 18 months of age, over a 15-month experimental period.

Received for publication July 10, 1953.

No report has been found of the blood composition of mature bulls being used in a bull stud. Therefore this investigation was undertaken to determine the monthly blood composition of Jersey, Guernsey, and Holstein mature bulls used continuously in a bull stud over a period of one year under semitropical (Louisiana) conditions.

EXPERIMENTAL

Fifteen bulls, (five Jerseys, five Guernseys and five Holsteins) of the L. S. U. Dairy Improvement Center Stud were used. The average age of each breed was 7.31 ± 1.33 years for the Jerseys, 5.63 ± 1.11 years for the Guernseys and 6.72 ± 1.57 years for the Holsteins. The average age for all bulls was 6.55 ± 0.74 years. Management and feeding practices were similar for each animal. Each bull was housed in an individual pen and had access to a pasture lot approximately 0.9 acre in area. Grass hay was fed during periods of poor pasture. Approximately ½ lb. of grain ration per 100 lb. of body weight was fed along with pasture and grass hay. Semen samples were usually collected from each bull once a week, one or two ejaculates being taken as needed. The semen production, fertility data, and physiological responses of these bulls have been reported earlier *(8)*.

Citrated blood was obtained from each bull on three consecutive days each month for a period of 1 year. The 3-day individual samples were pooled and analyzed. Hematocrit (packed red blood cells) values were determined with a Weintrobe hematocrit, hemoglobin by the acid hematin method using a Fisher hemometer standardized for 13.8 g. per 100 cc. of blood equal to 100%, plasma calcium by the Clark-Collip modification *(4)* of the Kramer-Tisdall method, plasma inorganic phosphorus by the Fiske and Subbarow method *(6)* using a Coleman spectrophotometer, alkaline phosphatase by the Bodansky method *(2)*, and the usual methods for the erythrocyte and leucocyte counts. Statistical analyses of the data were made according to Snedecor *(14)*.

RESULTS AND DISCUSSION

The range and mean values of monthly blood analyses for 15 breeding bulls of the Jersey, Guernsey and Holstein breeds over a 1-year period (1952) are shown in Table 1.

Hematocrit value (packed blood cell volume). The Guernsey bulls had a higher mean percentage of packed red blood cells (46.3%) than the Jerseys (42.3%) and Holsteins (39.5%). These differences were highly significant ($P < 0.01$). Statistical analyses also showed highly significant differences ($P < 0.01$) between bulls and a significant difference ($P < 0.05$) between months. Reid *et al. (11)* reported a range of 33.59 to 40.26% of packed red blood cells for young Holstein bulls. These values were determined at 3-month intervals. The monthly values reported herein ranged from 37.0 to 50.0% with a mean of 39.5 ± 1.8%, indicating a higher value of packed red blood cells in bulls used routinely in artificial insemination and in older bulls.

Hemoglobin. The Guernsey bulls had a higher mean hemoglobin value (12.2

TABLE 1

The hematocrit value, hemoglobin, plasma Ca, plasma inorganic P, alkaline phosphatase value, erythrocyte count and leucocyte count of 15 breeding bulls over a 1-year period

	5 Jerseys		5 Guernseys		5 Holsteins	
	Range	Mean S.E.	Range	Mean S.E.	Range	Mean S.E.
Hematocrit value *(%)*	29.5 –49.5	42.3 ± 0.9	34.0 –53.5	46.3 ± 1.2	37.0 –50.0	39.5 ± 1.8
Hemoglobin *(g.%)*	9.4 –13.3	11.6 ± 0.2	10.4 –14.0	12.2 ± 0.2	9.9 –14.4	11.6 ± 0.15
Ca *(mg.% plasma)*	8.19–15.20	10.47 ± 0.24	8.60–13.92	10.21 ± 0.20	8.10–12.48	10.26 ± 0.22
Inorg. P *(mg.% plasma)*	3.20– 7.50	4.55 ± 0.11	3.65– 7.50	4.86 ± 0.14	3.55– 6.15	4.51 ± 0.09
Phosphatase, Alkaline *(units/100 ml.)*	1.38– 2.64	2.11 ± 0.18	1.50– 3.76	2.95 ± 0.21	0.94– 2.36	1.49 ± 0.10
Erythrocytes *(Million/cu. mm. whole blood)*	5.07– 8.83	6.55 ± 0.35	5.80– 9.12	7.49 ± 0.39	6.53– 9.88	7.84 ± 0.25
Leucocytes *(per cu. mm. whole blood)*	4,130–15,950	8,580 ± 398	4,380–10,900	6,444 ± 139	4,650–12,680	7,416 ± 184

g.%) than the Jerseys (11.6 g.%) and the Holsteins (11.6 g.%), but this difference was not significant. However, there were monthly and annual significant differences among all breeds. Reid *et al. (11)* reported slightly higher figures for hemoglobin for young Holstein bulls, 12.07 to 15.16 g.%. It is possible that this was due to the younger age of their Holstein bulls. Other investigators *(3, 7, 9)* have reported hemoglobin values for different breeds ranging from 9.94 to 14.55 g.% with averages from 11.92 to 12.99 g.%. These bulls, however, were not in a breeding stud and represent only a few animals.

Calcium. There were similar mean values for plasma calcium among the three breeds—Jerseys 10.47, Guernseys 10.21, and Holsteins 10.26 mg.%. Reid *et al. (11)* reported a range of 8.79 to 11.65 mg.% for young Holstein bulls, which is in the range of the values of 8.10 to 12.48 mg.% for the mature Holstein bulls in this study. Thus, calcium values appear to be fairly constant in animals on an adequate diet.

Inorganic phosphorus. There was little difference in the mean values for plasma inorganic phosphorus for the different breeds. The values were Jerseys, 4.55; Guernseys, 4.86; and Holsteins, 4.51 mg.%, respectively. Previous studies by Rusoff *et al. (13)* have reported a decrease in inorganic phosphorus with age. The range of phosphorus values of the Holstein bulls in this study was 3.55 to 6.15 mg.%, whereas the range for younger Holstein bulls reported by Reid *et al. (11)* was much higher, 6.86 to 8.26 mg.%.

Alkaline phosphatase. There were significant differences among the three breeds. The Guernseys had a mean value of 2.95 units; Jerseys, 2.11; and Holsteins, 1.49. There were also significant differences ($P < 0.05$) among the animals in a breed. The values in this study are considerably lower than the alkaline phosphatase values reported for Holstein bulls by Reid *et al. (11)*, Their values were 6.09 to 12.15 units per 100 ml., and they pointed out that low alkaline phosphatase values were associated with semen collection. The lower phosphatase values in this study may be due to the regular weekly semen collections over a period of one year. Reid *et al. (12)* have reported that no relationship existed between plasma alkaline phosphatase levels and the age of bulls. Their phosphatase values for 23 bulls, from 17 to 128 months of age, ranged from 1.99 to 21.03 units, with an average of 8.98 units per 100 ml. plasma.

Erythrocytes. The Jersey bulls had the lowest mean erythrocyte value, $6.55 \pm 0.35 \times 10^6$ per cubic millimeter, of the three breeds, but the difference was not found to be significant. There was, however, a significant variation ($P < 0.05$) between animals. The Holstein bulls showed a range of 6.53 to 9.88×10^6 per cubic millimeter with a mean of 7.84×10^6. Younger Holstein bulls showed a range of 8.83 to 9.98×10^6 per cubic millimeter, as reported by Reid *et al. (12)*. This indicates a decrease in erythrocyte values with an increase in age, which was also indicated in the work of Reid *et al.*

Leucocytes. Considerable differences among the breeds were found for the leucocyte counts. The Jerseys showed a mean of $8,580 \pm 398$; Holsteins, $7,416 \pm 184$; and Guernseys, $6,444 \pm 139$ per cubic millimeter. These differences were highly significant ($P < 0.01$). Individual animals within a breed also showed

highly significant differences ($P < 0.01$). The leucocyte counts in this study for the three breeds were much higher than the values reported by Dimick and Thompson *(5)* on only one animal of each breed.

Effect of season of year on values. There were significant monthly variations ($P < 0.05$) for all of the different blood values with the exception of inorganic phosphorus values. McCay *(9)* has reported a slight increase in hemoglobin levels during the summer months. Figure 1 shows the average monthly blood

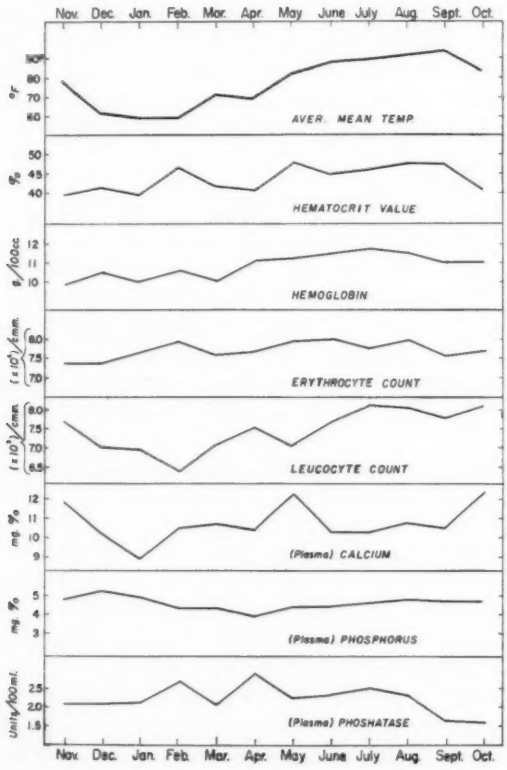


FIG. 1. Monthly trends of blood constituents of breeding dairy bulls.

values of the three breeds over a 12-month period. Hematocrit values, hemoglobin values, and leucocyte counts definitely increased during the summer months when the maximum environmental temperature began to increase over 80° F. Alkaline phosphatase values for all breeds definitely decreased during September and October. In August, the mean maximum environmental temperature was 91° F.; in September, 93°; and in October, 82.4°. This indicates a relationship between high environmental temperatures and packed red cell volume, hemoglobin, leucocyte count, and alkaline phosphatase values.

Single blood determinations thus are of little value in determining standards or comparing levels with values reported in the literature. Many factors, such as age, breed, environmental temperature, number of semen collections, and nutrition, may play an important role in the values obtained.

SUMMARY

Blood analyses of mature dairy bulls (Jersey, Guernsey, and Holstein breeds), being used in a bull stud were determined monthly over a period of one year. Significant breed differences were found for packed red cell volume, alkaline phosphatase values, and leucocyte counts.

Packed red cell volume, hemoglobin values, and leucocyte counts increased during the summer months when environmental temperatures increased over 80° F., while plasma alkaline phosphatase values decreased. Plasma calcium and inorganic phosphorus values and erythrocyte counts were not affected by environmental conditions.

ACKNOWLEDGMENT

The authors express their appreciation to G. F. D'Arensbourg, who aided in the collection of blood samples, and to H. H. Hester, Jr., for aid in the blood analyses.

REFERENCES

(1) Anderson, A. K., Gayley, H. E., and Pratt, A. D. Studies of the Chemical Composition of Bovine Blood. *J. Dairy Sci.*, **13**: 336. 1930.

(2) Bodansky, A. Phosphatase Studies. II. Determination of Serum Phosphatase. Factors Influencing the Accuracy of the Determination. *J. Biol. Chem.*, **101**: 90. 1933.

(3) Brooks, H. J., and Hughes, J. S. The Hemoglobin Content of the Blood of Dairy Cattle. *J. Nutrition*, **5**: 35. 1932.

(4) Clark, E. P., and Collip, J. B. A Study of the Tisdall Method for the Determination of Blood Serum Calcium with a Suggested Modification. *J. Biol. Chem.*, **63**: 461. 1925.

(5) Dimick, W. W., and Thompson, M. C. Clinical Examination of the Blood of Normal Cattle. *Am. Vet. Rev.*, **30**: 553. 1906.

(6) Fiske, C. H., and Subbarow, Y. The Colorimetric Determination of Phosphorus. *J. Biol. Chem.*, **66**: 375. 1925.

(7) Hamersma, P. J. Chemical Blood Studies. VII. *Onderstepoort J. Vet. Sci. An. Husb.*, **8**: 441. 1937.

(8) Johnston, J. E., and Branton, Cecil. Effects of Seasonal Climatic Changes on Certain Physiological Reactions, Semen Production and Fertility of Dairy Bulls. *J. Dairy Sci.*, **36**: 934. 1953.

(9) McCay, C. M. The Hemoglobin and Total Phosphorus in the Blood of Cows and Bulls. *J. Dairy Sci.*, **14**: 373. 1931.

(10) Reid, J. T., Ward, G. M., and Salsbury, R. L. The Relationship of Semen Production, Age, Plasma Calcium and Plasma Phosphorus to the Plasma Phosphatases of Dairy Bulls. (Abs.). *J. Dairy Sci.*, **30**: 546. 1947.

(11) Reid, J. T., Ward, G. M., and Salsbury, R. L. Simple Versus Complex Concentrate Mixtures for Young Breeding Bulls. I. Growth, Blood Composition, and Cost. *J. Dairy Sci.*, **31**: 429. 1948.

(12) Reid, J. T., Ward, G. M., and Salsbury, R. L. Effects of Certain Factors Upon the Level of the Plasma Phosphatases of Breeding Bulls. *Am. J. Physiol.*, **152**: 280. 1948.

(13) RUSOFF, L. L., FRYE, J. B., JR., AND SCOTT, G. W., JR. Blood Studies of Red Sindhi-Jersey Crosses. I. Hemoglobin, Hematocrit, Plasma Calcium and Plasma Inorganic Phosphorus Values of Red Sindhi-Jersey Daughters and Their Jersey Dams. *J. Dairy Sci.*, 34: 1145. 1951.

(14) SNEDECOR, G. W. *Statistical Methods.* 3rd ed. Iowa State College Press, Ames. 1940.

BACTERIOLOGICAL STUDIES ON HIGH-TEMPERATURE SHORT-TIME PASTEURIZATION OF ICE CREAM MIX[1, 2]

M. L. SPECK, C. A. GROSCHE,[3] H. L. LUCAS, JR., AND L. HANKIN
Departments of Animal Industry and Experimental Statistics
North Carolina State College, Raleigh

Pasteurization standards for different dairy products are concerned primarily with the complete destruction of all pathogenic bacteria which could conceivably be present in these products. In order to accomplish this under varying conditions, a margin of safety is provided by incorporating into the standards a somewhat higher temperature, or longer time, or both, than the minimum time and temperature necessary to effect this destruction. The present standard for ice cream mix recommended by the U. S. Public Health Service *(14)* of 155° F. for 30 minutes, being adequate in the above respects, does not limit pasteurization of mix to this time and temperature, but states "that nothing in this definition shall be construed as disbarring any other process which has been demonstrated to be equally efficient."

As a result of a number of studies *(4, 8, 9, 11, 12)* designed to establish a high-temperature short-time (HTST) process which would be equivalent bacteriologically to 155° F. for 30 minutes, the U. S. Public Health Service has recommended a tentative standard of 175° F. for 25 seconds *(6)*. This standard has made it possible in many areas to HTST pasteurize ice cream mix with units having a holding tube as part of the pasteurizer. Other studies *(1, 3, 13, 15)* have shown that there is a trend toward the use of pasteurizers in which ice cream mix would be held only momentarily at considerably higher temperatures.

This study was made to evaluate further the adequacy of the present tentative standard of 175° F. for 25 seconds and to provide information on the times required at higher temperatures which would be equivalent to 155° F. for 30 minutes in pasteurizing ice cream mix. Some experiments were conducted in the College Creamery to test the validity of the laboratory studies under practical plant conditions.

EXPERIMENTAL

Laboratory studies. In order to detect differences in pasteurization requirements resulting from variations in mix composition, six mixes were selected for use in this study. The total solids content varied from 33.4 to 42.4%, and the butterfat content varied from 4 to 18% with the proper adjustment in each mix

Received for publication July 13, 1953.

[1] Published with the approval of the Director of Research, North Carolina Agricultural Experiment Station, Raleigh, as Paper No. 493 of the Journal Series.

[2] This investigation was supported in part by a research grant from the National Microbiological Institute, of the National Institutes of Health, Public Health Service.

[3] Present Address: Department of Dairy Husbandry, University of Minnesota, St. Paul.

TABLE 1
Composition of ice cream mixes

Mix Ingredients	Mix No.					
	I	II	III	IV	V	VI
	(%)	(%)	(%)	(%)	(%)	(%)
Butterfat	4.0	10.0	12.0	12.0	12.0	18.0
Milk solids-not-fat	15.0	12.0	10.0	12.0	12.0	8.0
Cane sugar	14.0	14.0	15.0	15.0	17.0	16.0
Stabilizer	0.4	0.4	0.4	0.4	0.4	0.4
Total solids	33.4	36.4	37.4	39.4	41.4	42.4

of sugar and milk solids-not-fat relation to the fat content (Table 1). Thus, mixes representative of average commercial ice cream, as well as of premium ice cream mixes and milk-shake base, were used.

The basic ingredients used in the mix preparation were: raw cream (40% butterfat); pasteurized homogenized milk (4% butterfat); nonfat dry milk solids; cane sugar; gelatin (225 Bloom); and water as needed. One-liter batches of each mix were prepared by mixing the required amounts of cream, milk, and water as needed. This mixture was heated to about 90° F. in a steam chest. Nonfat dry milk was slowly sifted into the mixture while agitating vigorously with a mechanical stirrer. After heating to a temperature between 110° F. and 120° F., a blend of sugar and gelatin was added and dissolved. The temperature was then raised to 135 to 140° F., and the mix was homogenized in a Manton-Gaulin two-stage laboratory homogenizer (Model 25 CGB, 25 gal. per hour capacity) using 2,000 and 500 lb. pressure on the first and second stage valves respectively.

For the pasteurization tests 5-ml. portions of the mix were dispensed in sterile 120 × 20 mm. vials, which were sealed with rubber sleeve stoppers. The contents of the vials were pasteurized at 180° F. for 30 minutes to kill all but the most heat-resistant bacteria; the vials were then cooled and kept in ice water until used.

Two different test cultures were inoculated into the vials containing the ice cream mixes and their survival rates measured at different time and temperature combinations. A separate vial was used for each culture-mix-time-temperature combination.

Micrococcus sp. (No. MS 102) described by Barber *(2)* and *Microbacterium sp.* (No. 342-S-1) were selected, since both species show relatively high survivals in mix pasteurized at 155° F. for 30 minutes and they represent different morphological types.

Stock and test cultures of *Micrococcus sp.* were carried on agar slants of yeast extract-NZ case (YENZ) medium *(12)*. Cultures of *Microbacterium sp.* were carried on slants of yeast extract-proteose-peptone (YEPP) medium which was prepared by substituting Bacto proteose-peptone for the NZcase in the formula of the YENZ medium. Methods of carrying stock cultures and preparing test inocula were those described earlier *(12)*.

Each culture was heated in each of the six different mixes using each of

the following exposures: 175° F. for 5 to 50 seconds at 5-second intervals; 180° F. for 2 to 20 seconds at 2-second intervals; 185° F. for 1 to 10 seconds at 1-second intervals; and 190° F. for 1 to 5 seconds at 1-second intervals. A thermostatically controlled water bath was used to maintain the three lower temperatures, and an ethylene glycol bath to provide 190° F. The heating technique, the control vials used, and the manner of handling the pasteurized samples were those given by Grosche, Lucas, and Speck *(7)*. In the present study the U. S. Public Health Service standard of 155° F. for 30 minutes *(14)* was used as a basis for determining the times at the different temperatures which gave comparable bactericidal effects.

Two suitable dilutions of the samples were plated in duplicate using tryptone-glucose-extract-milk agar (TGEM), and the plates were incubated at 35° C. for 72 hours.

The preceding experiments were performed two times on separate occasions.

Plant studies. Three preliminary plant runs were made using the Vacreator and two using the Stevac tubular heater. An ice cream mix having a composition of 12% milk fat, 10% milk solids-not-fat, 15% cane sugar, and 0.35% stabilizer was prepared in 1,800-lb. batches in the College Creamery. The test inoculum, *Micrococcus sp.* (No. MS 102), was prepared as in the laboratory studies and grown on large surfaces of the medium to provide adequate inoculum. The suspended inoculum was added to the mix just 10 minutes prior to pasteurization and mixed thoroughly; an inoculation rate of approximately 500,000 to 1,000,000 organisms per gram of mix was obtained.

In the Vacreator experiments the inoculated mix flowed by gravity into an equilibrium tank, from whence it was drawn into a 200 gal. per hour homogenizer (Cherry-Burrell Super Homo) operating at 2,500 lb. pressure. The homogenizer forced the mix (temperature of 110° F.) into the Vacreator. For these experiments the temperature in the first chamber of the Vacreator was varied from 185 to 205° F. at 5-degree intervals. The temperatures normally were 160 and 110° F. in the second and third chambers, respectively, and a 40° F. treatment intensity was maintained. Bacteriological samples were collected as the mix emerged from the third chamber.

To provide a basis for determining the pasteurization efficiency of the various first-chamber temperatures, 30 gal. of mix, collected by means of a three-way valve placed between the homogenizer and Vacreator, was pasteurized at 155° F. for 30 minutes in a batch pasteurizer. Samples were taken directly from the vat after the holding period and cooled immediately in ice water.

In the experiments using the Stevac pasteurizer, the inoculated mix was forced by a Waukesha pump into the first section of the heater, where the temperature of the mix was raised to approximately 160° F. The mix was then drawn into a 400 gal. per hour homogenizer (Manton-Gaulin two-stage) operating at 2,000 and 500 lb. pressure on the first and second stage valves, respectively. It next passed into the final heating section of the Stevac, was heated to the temperature under test, and finally passed into the holding tube. The temperatures tested were from 165 to 190° F. at 5-degree intervals. The holding tube was adjusted to

give a 25-second holding time as determined using saline solution and a Sol-u-bridge. Ten- to 15-ml. samples were taken aseptically from the line through a petcock located immediately beyond the flow diversion valve. The samples were cooled immediately by immersion and agitation in ice water.

Samples were taken of the unheated inoculated mix and were pasteurized in the laboratory at 155° F. for 30 minutes to provide a basis for determining the temperature equivalent of the Stevac pasteurizer. These controls were used instead of vat pasteurization in the plant because when using the latter an unavoidable operational delay in commencing the pasteurization was found to lower the resistance of the test culture.

Samples were plated in duplicate, using TGEM agar, and plates were incubated at 35° C. for 48 hours.

RESULTS AND DISCUSSION

Laboratory studies. As in earlier work *(7)* the plate counts of the inoculated vials were corrected for the content of spore-formers and other heat-resistant flora as determined from corresponding uninoculated vials. The corrected counts then were converted to per cent survival figures.

A statistical analysis of the data revealed that differences in the composition of the mix had no effects on the destructive efficiency of the heat treatments as measured by the test inocula used in this study. A possible explanation for this may be that, although the total solids content varied from 33.4 to 42.4%, the cane suger present varied only from 14 to 17%. Studies of the relative effects of different sugars and milk solids on the susceptibility of bacteria to heat have shown that certain sugars are primarily important in this respect *(5, 7)*. Since mix composition was not an influential factor, the data obtained from all mixes

TABLE 2

Average percentage survival of Microbacterium sp. (No. 342-S-1) in ice cream mixes as related to temperature and time

Temperature tested							
175° F.		180° F.		185° F.		190° F.	
Time	Survival	Time	Survival	Time	Survival	Time	Survival
(sec.)	*(%)*	*(sec.)*	*(%)*	*(sec.)*	*(%)*	*(sec.)*	*(%)*
0[a]	100	0[a]	100	0[a]	100	0[a]	100
5	85.8	2	82.9	1	86.9	1	0.072
10	49.4	4	63.5	2	71.5	2	0.064
15	18.2	6	50.2	3	57.0	3	0.058
20	13.2	8	34.3	4	42.6	4	0.054
25	10.3	10	18.6	5	32.5	5	0.049
30	7.24	12	11.2	6	20.6		
35	3.53	14	6.32	7	12.4		
40	0.187	16	2.47	8	6.50		
45	0.100	18	0.616	9	3.03		
50	0.070	20	0.237	10	1.00		
% survival at 155° F. for 30 min.							
17.2		16.0		16.7		15.9	

[a] The 0 time represents the counts of the inoculated, unheated controls.

TABLE 3

Average percentage survival of Micrococcus sp. (No. MS 102) in ice cream mixes as related to temperature and time

Temperature tested							
175° F.		180° F.		185° F.		190° F.	
Time	Survival	Time	Survival	Time	Survival	Time	Survival
(sec.)	*(%)*	*(sec.)*	*(%)*	*(sec.)*	*(%)*	*(sec.)*	*(%)*
0[a]	100	0[a]	100	0[a]	100	0[a]	100
5	82.6	2	82.9	1	94.1	1	20.9
10	61.3	4	58.2	2	79.0	2	6.43
15	34.7	6	48.3	3	68.1	3	0.263
20	22.9	8	34.5	4	52.5	4	0.068
25	15.6	10	26.4	5	43.0	5	0.052
30	8.06	12	20.0	6	33.6		
35	5.01	14	9.35	7	22.7		
40	3.18	16	4.37	8	15.0		
45	1.55	18	1.59	9	4.16		
50	0.055	20	0.175	10	1.21		
% survival at 155° F. for 30 min.							
22.2		22.1		22.2		23.3	

[a] The 0 time represents the counts of the inoculated, unheated controls.

TABLE 4

Pasteurization times required at various temperatures to obtain the same bacterial destruction in ice cream mix as is obtained at 155° F. for 30 minutes

Temperature	Microbacterium (No. 342-S-1)		Micrococcus (No. MS 102)	
(° F.)	Observed[a]	Recommended[b]	Observed[a]	Recommended[b]
	(sec.)	*(sec.)*	*(sec.)*	*(sec.)*
175	16.0 ± 0.3	16.5	19.9 ± 0.7	21.2
180	11.0 ± 0.2	11.4	11.4 ± 0.2	11.8
185	6.4 ± 0.05	6.5	7.1 ± 0.05	7.2
190	0.25 ± 0.01	0.27	0.94 ± 0.03	0.99

[a] Mean observed in seconds with standard error of the mean.
[b] Mean plus standard error of mean × Student's one-tailed t taken at the 5% level.

inoculated with each test inoculum and subjected to a given heat treatment were combined in summarizing the data. This provided a total of 12 observations for each time of exposure, temperature, and test culture combination.

In Table 2 are presented the average per cent survivals at the various temperatures and times for *Microbacterium sp.* (No. 342-S-1). For each experiment on each mix the times at the different temperatures which were equivalent in lethality to 155° F. for 30 minutes were determined by linear interpolation using logarithms of per cent survival *(7)*. These then were analyzed to obtain the average times, the standard errors, and the "recommended" times shown in Table 4.

The survivals for *Micrococcus sp.* (No. MS 102) at different temperatures and times are given in Table 3. The average times required to effect results equivalent to 155° F. for 30 minutes along with their standard errors and "recommended" times are shown in Table 4. These results with *Micrococcus sp.* (No.

MS 102) agree with the work of Barber and Hodes *(3)*, who used the same culture. They concluded that pasteurization of ice cream mix at 175° F. for 25 seconds accomplished bacterial destruction comparable to, or greater than, pasteurization at 155° F. for 30 minutes.

Although the data (Table 4) indicate slight differences in the resistance of the two pure test cultures, the times required for their destruction were of the same order at the various temperatures.

M. freudenreichii (No. MS 66) and phosphatase, which possess greater heat resistance than the most heat resistant pathogen, *Mycobacterium tuberculosis*, were destroyed in 5 minutes or less at 155° F. *(10, 12)*. Thus, 155° F. for 30 min-

TABLE 5

Survival of Micrococcus sp. (No. MS 102) in ice cream mix pasteurized at various first-chamber temperatures in the Vacreator, and Vacreator temperature equivalent to 155° F. for 30 minutes

Test Temperature	Survival		
	Trial I	Trial II	Trial II
	(%)	*(%)*	*(%)*
Inoculated raw mix	100	100	100
155° F. for 30 min.	25.62	24.69	24.73
Vacreated mix:			
185° F.	32.23	25.47	25.55
190° F.	28.09	26.87	24.91
195° F.	17.36	3.22	14.91
200° F.	1.42	0.83	1.11
205° F.	0.22	0.33	0.24
Vacreator temperature *(° F.)* equivalent to 155° F. for 30 min.	191.15	190.46	190.09
	Observed mean = 190.57; standard error = ± 0.31; "recommended" temp. = 191.5		

TABLE 6

Survival of Micrococcus sp. (No. MS 102) in ice cream mix pasteurized at various temperatures for 25 seconds in the Stevac pasteurizer, and Stevac temperature equivalent to 155° F. for 30 minutes

Test temperature	Survival	
	Trial I	Trial II
	(%)	*(%)*
Inoculated raw mix	100	100
155° F. for 30 min.	16.10	8.87
Pasteurized in Stevac:		
165° F.	25.51	33.98
170° F.	22.29	23.16
175° F.	12.12	1.38
180° F.	1.61	0.203
185° F.	0.915	0.173
190° F.	0.983	0.308
Temperature *(° F.)* equivalent to 155° F. for 30 minutes	172.67	171.70
	Observed mean = 172.18; standard error = ± 0.48	

utes provide a large margin of safety. Since the temperature-time combinations here recommended for HTST procedures are equivalent to 155° F. for 30 minutes, it follows that they also provide a large margin of safety.

Plant studies. For each Vacreator experiment the first-chamber temperature equivalent to 155° F. for 30 minutes was determined by linear interpolation using logarithms of per cent survival *(7)*. This preliminary work indicated that a temperature of 191.5° F. in the first chamber will give a safe bactericidal effect (Table 5). The results agree satisfactorily with the study of Tracy *et al. (13)*. These investigators stated that maintenance of a temperature of 194° F. in the first chamber of the Vacreator gave bacterial destruction equivalent to 155° F. for 30 minutes. Furthermore, the present observations agree closely with the laboratory results, 190° F. for 0.99 seconds (Table 4). It has been shown *(13)* that mix normally is held at the desired temperature in the first chamber for about 0.75 second.

The results of the experiments using the Stevac pasteurizer indicated that a temperature of 172.2° F. for 25 seconds would give adequate pasteurization. The required temperature was determined by linear interpolation as was done for the Vacreator. These results agree with the results of the laboratory phase of this study and add further evidence supporting the adequacy of the U. S. Public Health Service standard of 175° F. for 25 seconds.

SUMMARY

In laboratory studies utilizing pure cultures of *Micrococcus sp.* (No. MS 102) and *Microbacterium sp.* (No. 342-S-1), the times required at temperatures of 175, 180, 185, and 190° F. to obtain pasteurization of ice cream mix equivalent to that effected at 155° F. for 30 minutes were investigated. Six mixes varying in composition to represent a range from milk-shake base to premium ice cream were used. Two experiments with each organism were conducted on each mix.

The composition of the mix was found not to affect pasteurization requirements. "Recommended" pasteurization times at 175, 180, 185, and 190° F. were, respectively, for *Micrococcus sp.* (No. MS 102) 21.2, 11.8, 7.2 and 0.99 seconds, and for *Microbacterium sp.* (No. 342-S-1) 16.5, 11.4, 6.5, and 0.27 seconds. The present standard of 175° F. for 25 seconds thus appears to be more stringent than 155° F. for 30 minutes.

Preliminary plant studies with the Vacreator showed adequate pasteurization of *Micrococcus sp.* (No. MS 102) to occur at a first-chamber temperature of 191.5° F. Similar studies with the Stevac pasteurizer set for 25 seconds holding time, indicated that a temperature of 172.2° F. would give proper pasteurization.

REFERENCES

(1) Barber, F. W., Spies, N. E., and Hodes, H. P. A Mojonnier Experimental, High-temperature, Short-time Pasteurizer Gives Satisfactory Bacterial Destruction on Ice Cream and Skim Milk. *Natl. Dairy Research Lab. Rpt.* No. 282X. 1949.

(2) Barber, F. W., and Hodes, H. P. A Culture Suitable for Evaluating Methods of Pasteurizing Ice Cream Mix. *Natl. Dairy Research Lab. Rpt.* No. 281. 1948.

(3) BARBER, F. W., AND HODES, H. P. A Mojonnier HTST Pasteurizer Gives Satisfactory Bacterial Destruction on Ice Cream Mix Inoculated with a Heat Resistant Organism. *Natl. Dairy Research Lab. Rpt.* No. 354. 1949.

(4) DOWD, L. R., AND ANDERSON, E. O. Study of Short-time-high-temperature Pasteurization of Ice Cream Mix. *J. Dairy Sci.*, **26**: 37. 1943.

(5) FAY, A. C. The Effect of Hypertonic Sugar Solutions on the Thermal Resistance of Bacteria. *J. Agr. Research*, **48**: 453. 1934.

(6) FUCHS, A. W. Personal Communication. Federal Security Agency, Washington 25, D. C. 1951.

(7) GROSCHE, C. A., LUCAS, H. L., AND SPECK, M. L. Pasteurization Requirements for Concentrated Whole Milk. *J. Dairy Sci.*, **35**: 793. 1952.

(8) MINTHORN, C. M. High-temperature Short-time Pasteurization of Ice Cream Mix. *Ice Cream Rev.*, **31**: 45. 1948.

(9) MYERS, R. P., AND SORENSEN, C. M. *Escherichia-aerobacter* Group in Ice Cream. (a) Determination from the Laboratory Standpoint. *Proc. Intern. Assoc. Ice Cream Mfrs.*, 36th Ann. Conv. 1936.

(10) SANDERS, G. P., AND SAGER, O. S. Heat Inactivation of Milk Phosphatase in Dairy Products. *J. Dairy Sci.*, **31**: 845. 1948.

(11) SPECK, M. L. *Natl. Dairy Research Rpt.* No. 201. Natl. Dairy Research Lab., Oakdale, Long Island. 1946.

(12) SPECK, M. L. The Resistance of *Micrococcus freudenreichii* in Laboratory High-temperature-short-time Pasteurization of Milk and Ice Cream Mix. *J. Dairy Sci.*, **30**: 975. 1947.

(13) TRACY, P. H., PEDRICK, R., AND LINGLE, H. C. Pasteurization Efficiency of the Vacreator When Used on Ice Cream Mix. *J. Dairy Sci.*, **33**: 820. 1950.

(14) UNITED STATES PUBLIC HEALTH SERVICE. *Frozen Desserts Ordinance and Code* Recommended by the U. S. Public Health Service. Federal Security Agency, Washington 25, D. C. 1940.

(15) WILSTER, G. H. The Dual Use of the Vacreator for Condensing Milk and Pasteurizing Ice Cream Mix. Ore. Agr. Expt. Sta., *Bull.* 430. 1945.

THE INFLUENCE OF GLYCEROL LEVEL, VARIOUS TEMPERATURE ASPECTS AND CERTAIN OTHER FACTORS ON THE SURVIVAL OF BULL SPERMATOZOA AT SUB-ZERO TEMPERATURES

W. J. MILLER AND N. L. VANDEMARK
Department of Dairy Science
University of Illinois, Urbana

Considerable progress has been made in the freezing of bovine spermatozoa *(1, 2, 3, 4, 5, 6, 10, 11, 12)* since it was discovered that glycerol would enable frog *(9)*, fowl *(8)*, and bull spermatozoa *(10)* to survive freezing. However, many problems still must be solved before this technique can be used widely for field artificial insemination of cattle.

The optimum glycerol level for use in the freezing of bull sperm has not been established by critical experiments. Smith *et al. (10)* reported that at glycerol levels of 10 and 15% excellent sperm survival rates were obtained, whereas a lower percentage of survival was obtained with 5% glycerol. Later Polge *et al. (5)* indicated that 10% glycerol was more desirable than 15%. Emmens *et al. (1)* stated that best results were obtained when 7.5 to 10% glycerol and 1.25% of a pentose were used. With unfrozen semen it was reported that 15% glycerol did not impair fertility *(6)*.

In reporting the optimum conditions for freezing bull sperm, Polge *et al. (6)* stated that samples should be thawed in a water bath at 40° C. However, it was not indicated whether other temperatures had been tried. Warming sperm to 40° C. presumably would be undesirable if the samples are to be stored after thawing.

Much of the British work has been done at a dilution of one part of semen to three parts of diluent *(3, 6)*, and the highest dilution reported was 1:40 *(7)*. In America much higher dilutions frequently are used in artificial insemination. Thus, some indication was needed of sperm survival during freezing and storage at low temperatures when diluted at rates being used in routine field breeding.

Optimum conditions for freezing bull sperm were considered to include the addition of the glycerol-sodium citrate solution at 5° C. with 12–20 hours of equilibration with the glycerol before freezing *(6)*. However, data were not presented supporting these recommendations.

Polge *et al. (6)* stated that the rate of freezing should not exceed 2° C. per minute between +5 and –15° C., although below –15° C. the rate could be faster. The same group indicated that results were similar whether samples were cooled from +2 to –20° C. at rates of 1 or 2° C. per minute *(10)*. Between –20 and –79° C., results were better when samples were transferred from alcohol baths which were successively 10° C. colder than when the temperature intervals were 20° C. *(10)*.

Received for publication July 16, 1953.

Freezing sperm to ordinary deep-freeze temperatures (–15 to –25° C.) is much easier than employing dry ice and ethyl alcohol to obtain a temperature of –79° C. Emmens *et al. (1)* have found indications that better results may be obtained by freezing bull sperm to –25° C. than to –79° C. Presumably their samples were frozen for only a short time. The authors have not been able to obtain survival of sperm which were frozen at –20° C. for periods ranging from 1 day to 2 weeks.

Since the earlier recommendations for freezing bull spermatozoa have not clearly defined the effects of variations in glycerol levels, rates of adding glycerol, rates of cooling and thawing, and storage temperatures, the present investigations were undertaken to determine the limits of some of these factors when bull semen was frozen in an egg yolk–citrate diluent.

EXPERIMENTAL AND RESULTS

All of the semen samples used in these studies were obtained from Holstein bulls which were approximately 2 years old. The semen was collected, diluted with two to six parts of diluent made up of 1:1 egg yolk–citrate (2.9% sodium citrate dihydrate) and then cooled to 5° C. over a period of 3 to 4 hours. The samples were then diluted 1:1 with a glycerol-sodium citrate solution containing the desired percentage of glycerol. The glycerol percentage was determined by volume (e. g., 14 ml. of glycerol plus 86 ml. of 2.9% sodium citrate solution equals a 14% glycerol sodium citrate solution). In the samples which were frozen, unless otherwise indicated, a 12–18 hour equilibration time was allowed before freezing. One-ml. samples were then frozen in 5-ml. plastic vials[1]. The freezing rate was about 1° C. per minute between 5 and –20° C. and then 2–5° C. per minute to –79° C., unless otherwise indicated.

Effect of glycerol level on motility of spermatozoa in storage. An experiment was designed to determine the effect of glycerol on unfrozen spermatozoa stored at 5° C. The following treatments were used on 10 ejaculates from eight bulls: *(a)* yolk–citrate (semen diluted 1:9 with 1:1 yolk–citrate); *(b)* 0% glycerol (semen diluted 1:4 with 1:1 yolk–citrate and this solution diluted 1:1 with 2.9% sodium citrate); *(c, d, e, f,* and *g)* 5, 10, 15, 20, 30, and 40% glycerol (semen diluted 1:4 with 1:1 yolk–citrate and this solution diluted 1:1 with glycerol-sodium citrate solutions containing 10, 20, 30, 40, 60, and 80% glycerol).

When glycerol was added slowly to semen diluted 1:1 with yolk–citrate diluent at 5° C., the percentage of motile spermatozoa was not greatly affected by the level of glycerol added up to 30%. When samples were stored for 7 days in various glycerol levels, there was no indication that the percentage of motile sperm in the higher levels declined more rapidly. The rate of motility was reduced in the samples containing 20% glycerol and drastically reduced in those containing 30% glycerol. This reduction in rate of motility was exhibited immediately and during storage was no more rapid than at lower glycerol levels.

Effect of sperm number and glycerol levels on survival of sperm after freezing.

[1] Manufactured by the Insemikit Company, Inc., Baraboo, Wisconsin.

TABLE 1

Effect of glycerol level and sperm numbers on the percentage of motile sperm after freezing to −79° C. (av. of 10 ejaculates)

Sperm numbers (million/ml.)	Glycerol level (%)			
	5	10	15	Av.
90	36	22	3.2	20.3
30	34	24	0.9	19.8
10	36	23	0.2	19.9
Av.	35.3	23.2	1.4	20.0

In a factorial experiment (10 ejaculates) 90, 30, and 10 million sperm per milliliter were frozen in 5, 10, and 15% glycerol. After freezing to –79° C., there was a higher percentage of motile sperm in those frozen in 5% glycerol than in those frozen in 10% glycerol (Table 1). There were few motile sperm when a 15% glycerol level was used. The concentration of spermatozoa (90, 30, and 10 million) did not affect the percentage of motile sperm after freezing at any of these glycerol levels.

Effect of glycerol level and thawing temperature after freezing and subsequent storage. In order to define more clearly the optimum glycerol level, 10 ejaculates were frozen in 2, 4, 6, 8, 10, and 12% glycerol, and 9 additional ejaculates were frozen in 4, 6, 8, and 10% glycerol. In a factorial experiment which partially overlapped this experiment, 13 ejaculates were frozen in 4, 6, 8, and 10% glycerol, thawed in water baths at 38 and at 5° C. and examined for motility immediately after thawing and on the following 1st and 3rd days. Those thawed at 38° C. were cooled slowly to 5° C. for storage.

When thawed in a water bath at 38° C., the 10 ejaculates frozen in glycerol levels including 2 and 12% showed means of 2 and 13% motile sperm, respectively. The corresponding means for the 19 ejaculates frozen in 4, 6, 8, and 10% glycerol were 29, 34, 35, and 24%. In later experiments in which glycerol level was not an experimental factor, a final concentration of 7% glycerol was used. The results of the factorial experiment involving glycerol levels, thawing temperatures, and time of examination are presented in Table 2. All of the samples

TABLE 2

The effect of thawing temperature, glycerol level, and days in storage on the percentage of motile sperm stored at 5° C. after freezing to −79° C. and subsequent thawing (Av. of 13 ejaculates)

Glycerol level (%)	Thawing temperature							
	38° C.				5° C.			
	Days stored				Days stored			
	0	1	3	Av.	0	1	3	Av.
4	28.5	17.3	5.1	17.0	29.2	21.7	19.8	23.9
6	31.5	22.4	9.2	21.1	37.7	33.8	23.5	31.7
8	33.1	15.0	4.6	17.6	41.5	33.1	17.3	30.6
10	19.5	3.6	0.8	8.0	33.1	18.5	6.0	19.2
Av.	28.2	14.6	4.9	12.2	35.4	26.8	16.6	20.6

deteriorated more rapidly on storage at 5° C. than is generally the case with unfrozen samples. This is in agreement with the observations of Smith *et al. (10)*. The rate of deterioration increased with each increase in glycerol level, and the samples thawed at 38° C. declined more rapidly upon storage at 5° C. than did those thawed at 5° C. Immediately after thawing, samples thawed at 5° C. exhibited a higher percentage of motile sperm than those thawed at 38° C. The advantage for those thawed at 5° C. increased with each increase in glycerol level.

Effect of rate and temperature of the glycerol addition and the equilibration time on the survival of sperm after freezing to –79° C. In a 3 × 3 × 3 factorial experiment 12 ejaculates were frozen in a final glycerol concentration of 7%. The glycerol solution was added to the diluted semen in 5, 3, and 1 equal portions at 4.5, 10, and 15.5° C. Samples of each of these combinations were frozen after 2, 6, and 18 hours of equilibration with the glycerol at 5° C. The samples in which the glycerol was added at 10 and 15.5° C. were cooled slowly to 4.5° C.

TABLE 3

The effects of rate of addition and temperature of addition of glycerol and equilibration time on the percentage of motile sperm upon thawing after freezing (av. of 12 ejaculates)

Equilibration time (hrs.)	Temperature (° C.)											
	4.5				10				15.5			
	No. of addition				No. of addition				No. of addition			
	5	3	1	Av.	5	3	1	Av.	5	3	1	Av.
2	48	48	45	47.4	44	43	45	43.9	41	38	38	39.1
6	49	51	47	48.8	48	50	46	47.9	42	45	43	43.6
18	46	47	46	46.3	43	46	42	44.0	42	43	42	42.5
Av.	47.8	48.6	46.0	47.5	45.0	46.5	44.3	45.3	42.0	41.8	41.4	41.7

before they were frozen. A slightly higher percentage of sperm survived freezing and thawing when the glycerol was added at 4.5° C. than when the addition was made at 10° C. (Table 3). Results at both 4.5 and 10° C. were better than those obtained when the glycerol was added at 15.5° C. ($P = 0.01$). Adding the glycerol in three portions gave results which were as satisfactory as when it was added in five portions. When the glycerol was added in only one portion, a slightly lower percentage of sperm survived the freezing process. Six hours of equilibration gave higher sperm survival rates than did either 2 or 18 hours ($P = 0.05$). However, when the glycerol was added at 4.5° C., the samples equilibrated for 2 hours had approximately the same percentage of motile sperm as those equilibrated for 6 hours. There was a lower percentage of motile sperm in the samples to which the glycerol was added at 15.5° C. and which were equilibrated for only 2 hours than in those in which the equilibration time was longer ($P = 0.05$), as shown in Table 3.

The effect of freezing rate on the survival of spermatozoa. Samples of 11 ejaculates were frozen at the rate of 0.25, 0.5, 1.0, 2.0, and 4.0° C. per minute between +5 and –20° C. and twice these rates between –20 and –79° C. Vials

containing samples of each ejaculate were also plunged directly into an alcohol bath at –79° C. The samples which were cooled at the rates of 0.25, 0.5, 1.0, 2.0, and 4.0° C. per minute had the following percentages of motile spermatozoa after thawing: 29.5, 40.0, 45.5, 43.6, and 43.6. A mean of 32.3% of the sperm were motile after thawing in the samples which were plunged directly into an alcohol bath at –79° C. There were no statistically significant differences among the samples frozen at 1.0, 2.0, or 4.0° C. per minute. All of the others had lower survival rates ($P = 0.05$).

Effect of storage temperature on survival of frozen sperm. Nine ejaculates were frozen and maintained at –23, –37, –51, –65, and –79° C. The desired temperatures were maintained by dropping pieces of dry ice, as needed, into ethyl alcohol baths. Samples were thawed after 1 hour, 1 day, 3 days, and 5 days.

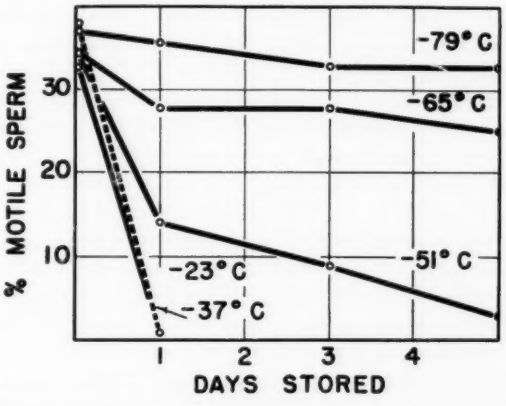


FIG. 1. The effect of freezing and storing bull sperm at various temperatures on the percentage of motile sperm at the time of thawing (Av. 9 ejaculates).

After 1 hour, the samples maintained at the various temperatures exhibited approximately equal motility (Figure 1). At the end of 1 day, samples stored at –79° C. exhibited approximately the same motility as did similar samples stored for 1 hour. The samples stored at –65° C. had declined somewhat in motility and those maintained at –51° C. had only one-third of the motility which they displayed at 1 hour. The samples at –23 and –37° C. exhibited practically no motility after 1 day in storage. After 5 days only three of the eight ejaculates stored at –51° C. showed motility upon thawing.

DISCUSSION

Bovine spermatozoa seem to have the ability to withstand high levels of glycerol at 5° C. without apparent decrease in numbers of motile sperm. The rate of motility is greatly reduced when levels of 20–30% glycerol are attained. Also, the type of motility is peculiar, in that the individual sperm appear to roll

very slowly. From the results of the experiments reported in this paper, it is evident that the critical level of glycerol for storage of sperm at 5° C. is much above the critical level for freezing bull sperm.

In the laboratory, glycerol levels of 6 or 8% have been found most satisfactory for sperm survival during the freezing of bull semen. However, no field results have been obtained to verify the belief that a glycerol level of 7% results in the maintenance of optimum fertility.

Frozen semen samples in plastic vials thawed in a water bath at 5° C. possessed a higher percentage of motile sperm immediately after the thawing than did those thawed at 38° C. The samples thawed at 5° C. retained motility longer when subsequently stored at 5° C. The optimum rate of thawing has not been determined.

It is important to point out that in these experiments a final concentration of 7% glycerol (by volume) was used in contrast to the 10 and 15% which was used by earlier workers *(6, 10)*. The results of the experiments reported in this paper indicate that the addition of glycerol at 4–5° C. is desirable; however, adding the glycerol at a temperature which is a few degrees higher probably would not result in an appreciable lowering of the sperm survival rate. When only 7% glycerol (final concentration) was added, the division of the glycerol solution into more than three portions was not beneficial, but adding all the glycerol directly did decrease motility slightly. Equilibrating the spermatozoa with the glycerol for 6 hours resulted in the highest percentage of motile sperm after freezing and thawing. Whether the equilibration time could be reduced below 6 hours with equally good results is not known. Reducing the time to 2 hours appeared to cause only a slight decrease in the percentage of surviving sperm when the glycerol was added at 4.5° C.

The greatest survival of spermatozoa resulted when the rate of freezing between 5 and –20° C. was 1–4° C. per minute. Reducing the rate of cooling below this rate resulted in an appreciable reduction in the spermatozoan survival. When they were frozen in plastic vials of the type used in this experiment, a considerable portion of the sperm survived freezing even when the vials were plunged directly into alcohol and dry ice at –79° C. However, the results were more satisfactory when the rate of cooling was not so rapid.

Samples which were frozen and maintained at temperatures between –23 and —65° C. apparently underwent changes at a rate which was rapidly accelerated as the temperature became warmer. The nature of these changes was not apparent. Preliminary results suggest that higher storage temperatures may be possible if higher levels of glycerol are used.

SUMMARY

When added slowly to bull semen diluted with yolk–citrate, glycerol (0–30%) had little effect on the percentage of motile sperm during storage at 5° C. No significant difference was observed in sperm survival after freezing when samples were diluted to contain 10, 30, and 90 million sperm per milliliter. Approximately

7 (6–8) % glycerol resulted in optimum sperm survival after freezing and storing at –79° C. Higher sperm survival rates were attained when samples were thawed in a water bath at 5° C. than at 38° C.

Adding glycerol to semen diluted with yolk–citrate at 4–5° C. gave slightly better results than adding it at 10 or 15.5° C. Adding the glycerol solution in three equal portions at 10-minute intervals resulted in slightly higher sperm survival after freezing than did making a complete addition at one time. Six hours of equilibration with the glycerol was found to be adequate for optimum survival of bull spermatozoa. Optimum results were obtained when the cooling rate from 5 to –20° C. was between 1.0 and 4.0° C. per minute.

Samples frozen and stored at various temperatures between –23 and –79° C. exhibited approximately equal motility when thawed after 1 hour. However, on storage those maintained at the warmer temperatures (–23 to –51° C.) declined in motility much more rapidly than did those at the colder temperatures.

ACKNOWLEDGMENTS

The authors wish to thank the Illinois Breeding Federation for contributing the funds which made this research possible. They also appreciated the assistance of K. D. Getz and J. D. Meller in some of the experiments.

REFERENCES

(1) Emmens, C. W., and Blackshaw, A. W. The Low Temperature Storage of Ram, Bull, and Rabbit Spermatozoa. *Australian Vet. J.*, **26**: 226. 1950.

(2) Parkes, A. S. Storage of Mammalian Spermatozoa at Low Temperatures. *Proc. Soc. Study of Fertility*, **2**: 12. 1950.

(3) Polge, C., and Lovelock, J. E. Preservation of Bull Semen at –79° C. *Vet. Record*, **64**: 396. 1952.

(4) Polge, C., and Parkes, A. S. Possibilities of Long-Term Storage of Spermatozoa at Low Temperatures. *Animal Breed. Abstr.*, **20**: 1. 1952.

(5) Polge, C., and Rowson, L. E. A. Fertilizing Capacity of Bull Spermatozoa After Freezing at –79° C. *Nature*, **169**: 626. 1952.

(6) Polge, C., and Rowson, L. E. A. Long-Term Storage of Bull Semen Frozen at Very Low Temperatures (–79° C.). IInd Intern. Congr. Physiol. and Pathol. Animal Reproduction and Artificial Insemination. Vol. III. *Artificial Insemination*. p. 90. Copenhagen. 1952.

(7) Polge, C., and Rowson, L. E. A. Results with Bull Semen Stored at –79° C. *Vet. Record*, **64**: 851. 1952.

(8) Polge, C., Smith, A. U., and Parkes, A. S. Revival of Spermatozoa after Vitrification and Dehydration at Low Temperatures. *Nature*, **164**: 666. 1949.

(9) Rostand, J. (Presented by Caullery, M. M.). Biologie Experimentale—Glycerine et resistance du sperm aux basses temperatures. *Compt. rend. acad. sci.* (Paris), **222**: 1524. 1946.

(10) Smith, A. U., and Polge, C. Storage of Bull Spermatozoa at Low Temperatures. *Vet. Record*, **62**: 115. 1950.

(11) Smith, A. U., Polge, C., and Smiles, J. Microscopic Observations of Living Cells During Freezing and Thawing. *J. Roy. Microscop. Soc.*, **71**: 186. 1951.

(12) Stewart, D. L. Storage of Bull Spermatozoa at Low Temperatures. *Vet. Record*, **63**: 65. 1951.

SULFUR DIOXIDE AS A PRESERVATIVE FOR HIGH MOISTURE LEGUME SILAGE [1]

L. DUFOUR,[2] R. P. NIEDERMEIER, C. E. ZEHNER, AND J. W. CROWLEY
Dairy Husbandry Department, University of Wisconsin, Madison

Studies on the use of SO_2 as a preservative for grass silage have been reported by several workers *(3, 4, 8)*. Sulfur dioxide has been compared with other preservatives, and the treated silage has been compared with grass silage made with no preservative. Knodt *(4)* reported that the SO_2 treatment resulted in a reduction of losses due to fermentation, preserved more carotene, and produced a very palatable silage. He concluded that it is an effective, economical preservative.

A series of cooperative experiments conducted at Beltsville *(8)* revealed that more carotene is preserved in SO_2-treated silage than in untreated silage. However, those data indicated that 7 lb. or more per ton of SO_2 decreased the palatability of the silage for dairy cows.

Kennedy and Allred *(3)* reported results of their experiments conducted with 9 regular silos and 32 small experimental silos during a 3-year period. The SO_2 treatment resulted in a decrease in fermentation losses as compared with the untreated material. However, the nutrients saved were not enough to justify the use of SO_2 as a preservative.

In addition to the references cited, there are many nontechnical articles on the use of SO_2 as a preservative, but there is not complete agreement on the value of its use. With the development of new machinery, more farmers are using the direct cut method of ensiling hay crops. This usually results in a higher moisture content in the silage. This experiment was designed to measure further the value of SO_2 as a preservative of high moisture legume silage ensiled by the direct cut method.

PROCEDURE

Twin concrete stave silos 8 ft. in diameter and 30 ft. high were filled on June 17-18, 1952, with a mixture of approximately equal parts of alfalfa and red clover, plus a trace of brome grass. The direct cut method was used with a ¾ in. theoretical cut. Wet conditions prevailed the week prior to harvesting with a rainfall of 2.29 in., and the forage as ensiled averaged 80% moisture. The wet

Received for publication July 22, 1953.

[1] Published with approval of the Director of the Wisconsin Agricultural Experiment Station. This study was supported in part with funds provided by the Ansul Chemical Company, Marinette, Wisconsin.

[2] This paper presented for partial fulfillment of the degree of Master of Science to the Graduate School of the University of Wisconsin. Supported in part by a scholarship from the Agricultural Research Council of Quebec, Canada. Present address, Dominion Experimental Farm, Normandin, P.Q., Canada.

conditions delayed harvesting until the red clover was in full bloom and the alfalfa was from half to full bloom at the time of harvesting.

The blower was set up so that the pipe could be swung to either silo. The silos were filled simultaneously, alternating loads as they came from the field. The north silo was filled with 24½ tons of chopped forage and treated with 5.66 lb. of SO_2 per ton, using the recommended procedure *(5)*. The south silo was filled with 24 tons of chopped forage with no preservative, and this served as the control. The silos were leveled after each load (approximately 2 ; ins). A burlap bag was filled with 50 lb. of fresh forage representing a composite sample of each load, and 10 of these bags were placed at regular intervals in each silo. Samples taken from these bags served as the source of the material for chemical analysis of the fresh forage and silage. Weights of the bags were recorded as the silos were emptied. After the silos were filled, the silage was tramped for two successive days and then a layer of moisture-resistant paper was placed over the top. Thermocouples were placed at various levels in the center of each silo to permit temperature studies.

The silos were opened January 2, 1953, and samples were taken from the bags as they were uncovered. Proximate feed analyses and carotene analyses were made, using AOAC *(2)* methods. The pH was determined with the Beckman pH meter. Statistical analyses were made by the methods of Snedecor *(7)*.

Two groups of eight milking cows each were used for a feeding trial. Group I was fed the untreated silage the first 30-day period and SO_2 treated silage the second 30-day period, while Group II received first the treated silage and then the untreated. The cows were fed twice daily at the rate of 1 lb. hay and 5 lb. of silage per 100 lb. body weight. Roughages and refused feeds were weighed on a group basis. Hay consisted of a medium quality grassy-legume mixture. Grain (15% total protein) was fed on the individual cow basis, taking into account both milk production and the condition of the cow. Since the cows were in advanced lactation, grain feeding levels were determined at the beginning of the feeding trial and left unchanged.

Changes in body weight and production of fat-corrected milk (FCM) were used to measure feeding value. Cows were weighed weekly, and a 3-day average weight was made at the beginning and end of each period. Milk weights were taken at each milking, and the fat test was based upon composite samples taken 3 days each week.

RESULTS AND DISCUSSION

Feeding Trial. Before feeding started, top spoilage was removed from each silo. The amount of top spoilage as determined by appearance was 11% in the untreated silage and 4.3% in the SO_2-treated silage. This difference was due to the fact that the moisture-resistant paper used to cover the silage deteriorated in the silo containing the untreated silage. The SO_2 silage was lighter in color and had less odor than the untreated silage.

Palatability. A preliminary feeding period of 10 days was used to change the cows on experiment from corn to grass silage. During this time there was

no apparent difference in palatability between the two silages, and the daily consumption was increased to an average of 65 lb. per cow. Palatability checks were made periodically during the experiment. This was done by offering a cow both silages at the same time and noting her preference. Although both silages were palatable to all cows, their first choice was the silage to which they were accustomed. Upon extending these palatability tests to other cows not used in this trial which were being fed corn silage, a slight preference was shown in favor of the SO_2-treated silage.

Feed consumption. Feed consumption for the entire feeding trial is summarized in Table 1. No cows were "off feed" during the 60-day feeding trial. Feed weigh-backs were not necessary for silage or grain, but the cows did not eat the average allotment of 1 lb. of hay per 100 lb. of body weight daily. Group II

TABLE 1

Average daily feed consumption and milk production

	Silage		Hay		Grain		Production of FCM	
	SO_2	Untreated	SO_2	Untreated	SO_2	Untreated	SO_2	Untreated
	(lb.)	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*	*(lb.)*
GROUP I 6 Holsteins 2 Guernseys	65	65	6.99	7.54	10.3	10.3	25.40	27.18
GROUP II 6 Holsteins 2 Guernseys	65	65	10.06	9.37	10.3	10.3	25.43	23.48
Av. of all cows	65	65	8.52	8.45	10.3	10.3	25.4	25.3

consumed more hay than did Group I. This was because of individual cow variation, and this difference persisted when cows in Group II were switched from the SO_2-treated to the untreated silage. Average daily hay consumption for all cows fed SO_2-treated silage was not significantly different from the average for cows fed the untreated silage.

Body weight. During the first 30-day period the eight cows eating the untreated silage increased in average weight from 1,305 to 1,329 lb. (+ 24 lb.). During the same period the eight cows eating the SO_2 silage increased in average body weight from 1,320 to 1,346 lb. (+ 26 lb.). Upon reversing the groups for the second 30-day period, there was an average increase of 26 and 14 lb. per cow for the SO_2 and untreated silages, respectively. The small differences in body weight gains were not statistically significant.

Milk production. The average daily production of FCM is shown in Figure 1. Both groups of cows were very persistent in milk production during the 60-day period. Group 1 averaged 27.2 lb. of FCM per cow at the beginning and 24.0 lb. at the end of the 60-day period; Group II declined from 25.2 to 22.0 lb. during the same time. During the first 30-day period Group II, receiving the SO_2 silage, decreased 0.6 lb. of FCM per cow daily, and Group I, receiving the untreated silage, decreased 0.2 lb. When the groups were reversed the second 30 days, Group I, receiving the SO_2 silage, decreased 3.0 lb., and Group II, receiving the

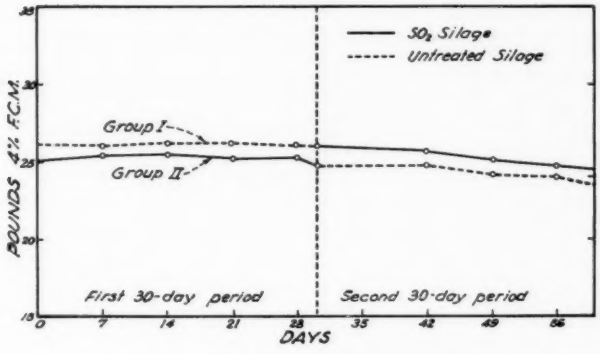


FIG. 1. Average daily production of FCM.

untreated silage, decreased 2.6 lb. For the 60-day period the cows fed SO_2 silage averaged 25.4 lb. of FCM, and the cows fed untreated silage averaged 25.3 lb. The analysis of variance of milk production *(7)* did not show a statistically significant difference between cows fed the SO_2 and untreated silages.

Chemical analyses. Samples for the analyses were taken from the 10 bags of forage placed at regular intervals in each silo. Fresh forage samples were frozen for later analysis. Silage samples were collected as the bags were uncovered and frozen for a short time before being analyzed. Moisture and pH determinations were made prior to freezing. Duplicate analyses were run on each sample according to official methods *(2)*. Therefore, the analyses shown in Table 2 are the averages of the 20 determinations for the fresh forage and the silage samples from each silo.

As shown by Table 2, the silos were filled with a high moisture forage. Both silos had drains, and there was considerable seepage from each of the silos. There was no difference in the moisture content of the fresh forage; however, the statistical analysis of the difference in moisture between the two silages was very significant. Moisture was determined by drying the silage to a constant weight at 90° F. Using this method, there is no correction for possible variations

TABLE 2

Chemical analyses of fresh forage and silage

			Average total composition, dry matter basis					
	Moisture	pH	Protein	E.E.	Fiber	N-free extract	Ash	Carotene
South silo: (untreated)	*(%)*		*(%)*	*(%)*	*(%)*	*(%)*	*(%)*	*(mg./lb.)*
Fresh forage	79.2		14.1	1.6	31.1	44.7	8.5	22.3
Silage	78.8	5.2	12.3	4.0	38.4	36.8	8.4	51.0
North silo: (SO_2 treated)								
Fresh forage	79.8		14.3	1.6	30.7	44.8	8.6	24.1
Silage	76.2	4.4	14.1	4.0	31.4	42.2	8.2	40.4

in the volatile materials in the two silages. Any error due to volatile materials would also affect the percentage of other constituents analyzed on a dry matter basis.

The difference in pH shows a marked effect of the SO_2 on acidity. As was true of moisture, there was no difference in the proximate feed analyses of the fresh forage put into the silos. This is to be expected, because the alternate load method of filling was used. The difference in the protein content of the two silages as shown in Table 2 was statistically significant. This difference is due chiefly to the low protein content of the top third of the untreated silage. When samples taken from the top third of each silo are excluded from the statistical analysis, the difference in protein is not significant. As usually shown in silage analyses, there was an increase in the percentage of crude fiber in both silages as compared to the fresh forages.

The difference in the crude fiber content of the two silages was statistically very significant. There are several possible reasons for this difference in the analyses. Other workers have shown *(1, 4)* that SO_2 silage retains more of the sugar in the fresh forage than does untreated silage. This might result in the analysis showing a smaller increase in the percentage of crude fiber in the SO_2 silage. Also, since the percentage of crude fiber is figured on a dry matter basis, the higher percentage of crude fiber in the untreated silage may be due partially to errors in the moisture determination. For example, a difference in volatile material driven off in drying the samples could explain part of the difference in crude fiber. However, there is no significant difference between the ash content of the two silages. Therefore, the loss of sugar or volatile materials does not seem to be a logical explanation for the difference in crude fiber. Another possible cause for the difference in crude fiber is the difference in pH of the silages.

There is no statistically significant difference in the ether extract or carotene content of the two silages. An increase of both is shown in the silage over the fresh forage. When the official methods of analyses are used, these increases are often present. They are due to the production of ether-soluble substance and carotene-like pigments *(6)* in the process of silage fermentation.

Temperature. Thermocouples were placed in the center of each silo every 5 feet from bottom to top. Temperatures of the silage were taken as the silos were filled and thereafter at regular intervals until the silage had reached a constant temperature.

As a result of the settling of the silage, some of the thermocouples were pulled loose. Also, the temperature of both silos remained low throughout the study, never going over 100° F. This may be accounted for by the rapid filling and high moisture content of the forage. The data do indicate that there was an increase in temperature within 2 hours after filling. The temperature continued to increase for 3 to 5 days and returned to atmospheric in about 4 weeks.

No conclusions as to the effect of the SO_2 preservative on temperature seem justified from the limited data. However, there is an indication that the SO_2 silage reached the maximum temperature more quickly than did the untreated silage. Also, the temperatures of the SO_2 silage were consistently 3 to 4 degrees less than those of the untreated silage.

SUMMARY

Legume silage harvested by the direct cut method was used to measure the value of SO_2 as a preservative. Comparisons were made between SO_2-treated and untreated silages on the basis of a feeding trial and chemical analysis. Both silages were palatable, and the cows consumed an average of 65 lb. per day during the trial. There were no differences between the two silages on the basis of milk production or body weight during the 60-day feeding trial. The analyses showed the SO_2-treated silage was lower in pH, moisture, and fiber, and higher in protein, than the untreated silage. These differences were statistically significant. No significant difference was shown for ether extract, ash, and carotene.

ACKNOWLEDGMENT

The help of the Department of Agricultural Engineering in filling the silos is acknowledged and appreciated.

REFERENCES

(1) Archibald, J. G. Sugar and Acids in Grass Silage. *J. Dairy Sci.*, **36**: 385. 1953.
(2) Association of Official Agricultural Chemists. *Official and Tentative Methods of Analysis*, 6th ed. Washington, D. C. 1945.
(3) Kennedy, W. K., and Allred, K. R. Are Silage Preservatives Good Buys? N. Y. State Agr. Expt. Sta., *Quart. Bull.* **19**: 11. 1953.
(4) Knodt, C. B., Skaggs, S. R., and Williams, P. S. Sulfur Dioxide for Preservation of Forage. Pa. Agr. Expt. Sta., *Tech. Bull.* 552. 1952.
(5) Knodt, C. B., Skaggs, S. R., and Williams, P. S. Sulfur Dioxide for Preservation of Forage. Pa. Agr. Expt. Sta., *Bull.* 552-P. 1952.
(6) Quackenbush, F. W., Steenbock, H., and Peterson, W. H. The Effects of Acids on Carotenoids. *J. Am. Chem. Soc.*, **60**, Sec. **2**: 2937. 1938.
(7) Snedecor, G. W. *Statistical Methods*, 4th ed. The Iowa State College Press, Ames. 1946.
(8) U. S. Department of Agriculture. Preliminary Experiments with Sulfur Dioxide as a Preservative for Forage Crops Show some Favorable Results. *Report of the Chief*, Bur. Dairy Ind., Washington, D. C. 1950.

THE EFFECT OF THE ENSILING PROCESS ON WILD ONION AND RAGWEED FLAVORS IN SILAGE AND IN MILK

R. E. BRUBAKER AND P. M. REAVES
Department of Dairy Husbandry
Virginia Polytechnic Institute, Blacksburg

Babcock *(1)* reported that garlic flavor and odor were detected in milk samples taken 1 minute after feeding garlic. After 10 minutes, a high degree of intensity of flavor was reached. The objectional odor persisted 4 hours after feeding but at 7 hours had practically disappeared. Many weeds, including bitterweed, tarweed, wild radish, and mustard, have been reported to cause objectional flavors in milk *(2)*. Ragweed and sneezeweed also have been responsible for off flavors. Most of the difficulty has been observed during dry weather when pasture was scant and cows were not very selective in their grazing. Wylie and Hinton *(3)* reported that dried wild onion tops or cured hay containing wild onion tops produced no undesirable flavors.

Forage often contains ragweed. This occurs largely in stubble fields where clover or lespedeza has been seeded in the grain crop. Farmers have inquired as to whether this mixture including ragweed could be ensiled and successfully fed to milking cows. The same question has arisen in regard to ensiling grass and legume crops in the spring when they are heavily infested with wild onion. It was with these questions in mind that the following studies were made.

EXPERIMENTAL PROCEDURE

Silages were made from forage containing wild onion and ragweed. The trials were designed to determine if the flavor and odor of these plants would disappear during the ensiling process.

Forage containing 85 to 90% of mixed grasses and 10 to 15% of wild onion *(allium vineale)* was chopped and packed in a miniature silo. Ground corn was added at the rate of 225 lb. per ton as a preservative. Weights were placed on the top of the silage to furnish approximately 300 lb. of pressure per square foot of surface. The silo was opened 56 days after filling.

A cow was fed 10 to 12 lb. of the silage before each milking for four successive days. The time interval between feeding the silage and milking ranged from 35 to 70 minutes. From 5 to 7 lb. were consumed in this period of time. The remainder was ultimately consumed. The milk from this cow was examined immediately after milking and also after being cooled. The latter examination was made on this milk and on samples of milk from cows fed normal feeds. Three persons made observations for odor and flavor of the milk.

Forage containing about 55% of clover and wheat stubble and 45% ragweed was ensiled in a standard upright silo. Molasses was added as a preservative. The silo was filled in September 1952 and was opened in March 1953. Four milking cows were fed the silage at various intervals, ranging from 15 to 90 minutes,

Received for publication August 3, 1953.

before milking. The milk was cooled in cans in a wet storage. Samples were taken at the milk plant for examination. Control samples of milk were secured in the same manner from cows that were fed corn silage before milking. Two test periods of 1 week each were used to determine the flavor and odor of the milk. One period was immediately after the silo was opened and the other was 3 weeks later, after approximately 15 ft. of the silage had been removed.

RESULTS

The silage containing the wild onion had an undesirable, strong odor resembling the flavor of pickled onions. However, the fresh wild onion odor was not present. The draining which occurred during the early stages of ensiling had a pronounced onion odor. The silage was unpalatable.

Every sample of milk from the cow fed the onion silage contained a distinct onion odor. The flavor was less pronounced than the odor.

The silage containing the ragweed had a sweet aroma with no detectable ragweed odor. Although the cows ate the silage fairly well, it did not appear to be as palatable as corn silage.

Feed flavor, rated from slight to distinct, was found in 21 out of 28 samples of milk from the cows fed the ragweed silage. All samples from cows fed corn silage contained feed flavors. No ragweed flavor or odor was detected in any sample of milk obtained from cows fed ragweed silage.

SUMMARY

The ensiling process did not destroy the substance causing the onion flavor nor reduce it to a nondetectable level.

It appears that in this trial the ensiling process either destroyed the substance causing ragweed flavor or reduced it to a level that could not be observed in the silage or milk.

REFERENCES

(1) Babcock, C. J. Effect of Garlic on the Flavor and Odor of Milk. U. S. D. A., *Bull.* 1326. 1925.

(2) Roadhouse, C. L., and Henderson, J. L. *The Market Milk Industry.* 2nd ed. McGraw-Hill Book Co., New York. 1950.

(3) Wylie, C. E., and Hinton, S. A. Pasture Management for the Prevention of Onion Flavor in Milk. Tenn. Agr. Extension Service, *Leaflet* 89. 1947.

FAT SEPARATION IN EVAPORATED MILK
I. HOMOGENIZATION, SEPARATION, AND VISCOSITY TESTS[1]

R. B. MAXCY[2] AND H. H. SOMMER[3]
Department of Dairy and Food Industries
University of Wisconsin, Madison

The rising of fat in evaporated milk on prolonged storage will inevitably occur since the density of the fat particles is lower than that of the concentrated milk plasma in which they are suspended. It has been shown that the velocity of rise of individual fat globules in milk plasma is in good agreement with the velocity as predicated by Stokes' law *(5)*. Troy and Sharp *(7)* also found the velocity of rise of globule clusters in general agreement with this law. Their observations on clusters were less precise, however, because of inherent complications arising from the irregularities in the shapes of clusters and the occlusion of plasma within the clusters.

Accordingly, it must be expected that the factors controlling fat separation in evaporated milk are: the size of the fat particles, the difference in density between the fat particles and their suspending medium, and the viscosity of the suspending medium.

The size of the fat globules is obviously of first importance, since the velocity of rise is inversely proportional to the square of the globule radius. The importance of smallness is further accentuated through density considerations.

The difference in density between the fat particles and the medium in which they are suspended does not lend itself to direct control in a product of defined composition such as evaporated milk. This factor may, nevertheless, be important to an understanding of differences in fat separation. Insofar as heavier components become associated with the surface of fat globules by adsorption or coagulation, the density of the fat particles is increased. Through this effect the density of the fat particle can approach, equal, or even exceed that of the suspending medium, as smaller globule sizes are obtained, or as the amount of associated material is increased by processing conditions. Smallness of globules is important in this connection because the ratio of area to volume varies in inverse proportion to the radius of the globules.

The density of the suspending medium in evaporated milk is not positively fixed, even though the ratio of solids-not-fat to water is closely controlled. In aqueous solution the density of the three main classes of components of solids-not-fat ranges from about 1.35 for proteins to 1.63 for lactose and 2 to 3 for the

Received for publication August 3, 1953.

[1] Published with the permission of the Director of the Wisconsin Agricultural Experiment Station.

[2] Present address: Geo. J. Meyer Manufacturing Co., Milwaukee, Wisconsin.

[3] Deceased May 8, 1953.

milk salts. In normal milk the content of salts and lactose is relatively constant. On the other hand, the casein content is directly related to the quantity of butterfat. Since evaporated milk is standardized to a definite ratio of solids-not-fat to fat, the quantity of casein would be greater in evaporated milk made from milk with a high butterfat content than from milk with a low butterfat content. Thus, the evaporated milk with a high casein content would show a low density of the suspending medium. Even though this consideration has theoretical significance, it is not obvious how density should be considered for a nonhomogeneous medium comprising particles that are relatively large.

In connection with the density factor, it is interesting to note that fat separation in unconcentrated, homogenized, sterilized milk is less troublesome than in evaporated milk, presumably because of the lower density of the suspending medium. This condition exists even though the apparent viscosity is somewhat less than in evaporated milk.

The viscosity factor in Stokes' law relates to the viscosity of the suspending medium. For ideal application, the medium should be homogeneous and should exhibit true viscous flow characteristics. Neither of these conditions obtains in the concentrated milk plasma of evaporated milk. In unheated skimmilk, however, fat globules rise in good agreement with Stokes' law; this suspending medium is not perfectly homogeneous, containing casein particles up to 0.780 μ in diameter *(4)*. As the fat globule size is decreased by homogenization, and as the protein particles are increased in size by coagulation to sizes that may exceed the size of the fat globules, the system becomes more difficult to interpret in relation to Stokes' law.

The "viscosity" of evaporated milk decreases rapidly on vigorous agitation and slowly during quiescent aging. "Age thinning" of evaporated milk is retarded significantly by cool storage temperatures *(3)*. These facts indicate that the suspending medium in evaporated milk does not exhibit true viscous flow characteristics.

Industry practices in seeking to minimize fat separation in evaporated milk have been: *(a)* efficient homogenization, *(b)* attainment of maximum viscosity, just short of "graininess," *(c)* cool storage, and *(d)* periodic inversion of the cans during storage.

In connection with a study of fat separation in evaporated milk, the following tests were selected or developed, and evaluated.

METHODS

A. A Test to Rate the Effectiveness of Homogenization.

It is generally acknowledged that careful control of the pressure of homogenization alone does not afford assurance that the fat break-up and dispersion will be adequate. The other essential factors, such as valve design and condition, do not lend themselves to brief, descriptive specification and, in fact, have not been fully resolved. Assurance of proper homogenization must, therefore, be sought

through objective tests applied to the homogenized product, rather than through specification of homogenizing conditions.

Microscopic observation of the globule sizes in the homogenized product is the obvious and quick method of checking on the effectiveness of homogenization. This approach, however, lacks strict objectivity; its main use is in yielding a quick general impression; it does not lend itself to the recording of an "effectiveness rating" for later consideration in relation to the various degrees of fat separation that occur in the stored products. Attempts to make this approach objective are laborious, entailing the observation of a number of microscopic fields and complete globule counts by size groups; even then the personal factor enters, and the final rating of the data is arbitrary. It was for these reasons that the effectiveness of homogenization in the U.S.P.H.S. definition for homogenized milk was specified in terms of relative freedom from fat separation on 48-hour quiescent storage.

The evaluation of homogenization by means of a centrifugally accelerated fat separation test has received attention by several manufacturers of evaporated milk. In addition, Snyder and Sommer *(6)* described a test of this type in which the diluted product was centrifuged in a Babcock milk test bottle and the cream layer was read in terms of the Babcock test scale. A difficulty of this test is that the cream layer frequently lacks distinctness, especially when the fat is lightly pigmented. In the test described below, the fat separation is measured by fat tests to determine the fat enrichment that has occurred in a selected upper layer as a result of centrifuging.

Procedure. In this work 50 ml. of the homogenized milk at room temperature was measured into a 50-ml. centrifuge tube (round bottom, ungraduated). For evaporated milk, the test was applied to the concentrated milk before sterilization, diluting it with an equal volume of water, and measuring 50 ml. of this diluted product into the centrifuge tube. The samples were centrifuged for 10 minutes at 1,500 r.p.m. (International Centrifuge, Head No. 240, radius 8 in. to the bottom of the extended pocket). With continuous, gentle suction applied through an assembly as illustrated in Figure 1, the surface of the centrifuged milk was scanned with the suction inlet barely (or intermittently) in contact with the surface. This was continued until 10 ml. had been collected, as measured in the graduated receiving tube. After thorough mixing of the 10-ml. sample its fat content was determined.[4] From the known percentage fat content of the uncentrifuged sample *(A)* and the found percentage fat content of the 10-ml. sample *(B)* the per cent enrichment was computed as follows:

$$\text{Per cent enrichment} = \frac{(B - A)}{A} \times 100$$

[4] In the present study the fat content was determined by the Babcock test, applied to an 8.8-ml. sample in an 8% Babcock test bottle. No water was added to compensate for the reduced volume of the bottle charge before adding the sulfuric acid. Ten ml. of sulfuric acid was used, added in three separate portions with vigorous agitation for 2 minutes after each addition. The 8.8-ml. sample was considered to be a "half sample," and the Babcock reading was multiplied by 2.

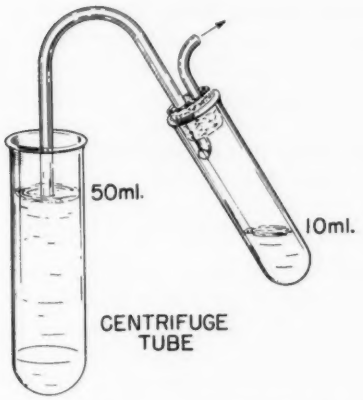


FIG. 1. Assembly for removing the upper 10 ml. for determining the effectiveness of homogenization.

The per cent enrichment might be considered as an effectiveness rating that parallels the tendency for separation and is inversely related to the size of the fat particles. The effectiveness rating may range from 0 for perfectly homogenized milk to approximately 400 for unhomogenized milk containing 4.0% fat.

B. Gravity Fat Separation Test

If the centrifugal test, as just described, is to measure differences in the effectiveness of homogenization, it must be applied before the other factors that affect fat separation have been altered by additional processing. In evaporated milk the centrifugal test should be applied before sterilization of the product. On the other hand, any fat separation test applied after sterilization will reflect not only the effectiveness of homogenization but also the consequences of protein coagulation and increases in viscosity. The inclusion of these additional factors, however, is precisely what is desired in a test to determine how effectively fat separation during storage of the product has been precluded.

An accelerated test for the latter purpose should recognize that "age-thinning" of evaporated milk during storage is part of the fat separation problem. For this reason the test that was adopted to measure fat separation tendencies included the acceleration of "age-thinning" through an elevated temperature.

Procedure. The test was performed in duplicate by placing two 14½ oz. cans of the evaporated milk in an upright position in an incubator at 100° F. immediately after the sterilization of the product. The cans remained undisturbed for exactly 7 days. Then, with careful handling to avoid mixing, the top of each can was cut out and a 25-ml. sample was removed from the upper surface. This removal and measurement was conveniently accomplished by the use of a 25-ml. pipette with its inlet tip bent upward. This tip was inserted in the center of the can so that the rim of the tip was parallel to and just below the surface.

By means of very gentle suction the pipette was slowly filled to its mark, keeping the inlet tip just below the surface but otherwise stationary. The fat content of the 25-ml. portion was determined by means of the Mojonnier fat test. The known fat content of the evaporated milk was subtracted from the found fat content in the 25-ml. sample and the difference was expressed as "per cent enrichment" by calculation as in the preceding test. This also may be spoken of as a fat separation rating.

C. Viscosity Measurement

Insofar as the viscosity measurement is to indicate the probable rate of fat rise in the product, the measurement ideally should be confined to the viscosity of the medium in which the fat particles, or fat-containing particles, are suspended. It is obviously impossible to attain this ideal; the measurement is of necessity confined to the rheological properties of the product as it exists.

The "viscosity" of the evaporated milk decreases on vigorous agitation, even after the weak, continuous gel, which may be evident immediately after sterilization, has been disrupted. In other words, evaporated milk exhibits plastic flow characteristics, which presumably should be recorded in terms of "yield value" and "consistency." It is, however, questionable whether the "yield value" has any reality in terms of the product as a whole. After the gel has been disrupted, the "yield value" most probably reflects the structural stability of suspended particles of indeterminate size and shape. The medium in which the particles are suspended undoubtedly exhibits true viscous flow.

In order to measure plastic flow characteristics, the flow rates of each sample must be measured at a number of different pressures or applied forces. Such a procedure might be used to provide information as to the structural stability of suspended particles in evaporated milk. It is, however, not apparent how such data should be interpreted in relation to the fat separation problem. At any rate, in the study in which the present methods were applied the flow of evaporated milk samples was measured under a single set of conditions, and the observed flow rates were expressed in terms of viscosity units. The plastic flow characteristics are tacitly acknowledged, and the results are kept on a basis that justifies comparisons between samples, in that the same set of conditions was used for all samples.

The modified Gardner Mobilometer. The instrument that was used for measuring the viscosity of evaporated milk was a modified Gardner Mobilometer *(1)*. With this instrument the viscosity was measured by timing the descent of a disc or piston through the liquid in a vertical cylinder of uniform bore. A stem, attached to the piston, served to control the positioning, release, and timing of this disc or piston. The applied force could be varied by placing weights on a small pan at the top of the stem.

It has been found that this type of instrument, when used for liquids that exhibit true viscous flow, yields flow rates that are directly proportional to the applied forces over a wide range of forces; deviation finally occurs, as in all

viscosity methods, when the velocity is sufficiently high to produce turbulence. This type of instrument was originally adopted in this laboratory for cream viscosity measurements to obviate erratic results that will occur with capillary efflux instruments when the size of suspended particles approaches or exceeds the bore of the capillary.

The modifications consist of the following features: *(a)* a leveling stand for holding the removable cylinder, the entire assembly being of suitable design for placement in a water bath for convenient and accurate temperature control; *(b)* a stem guide to fit the top of the cylinder; and *(c)* a piston-like plunger of suitably chosen clearance in relation to the cylinder diameter, but with four small high points on the piston rim to serve as centering guides with a minimum of friction against the cylinder wall. The hollow piston-like plunger is illustrated in Figure 2, and the entire assembly, in Figure 3. By using a piston, instead of a disc of limited thickness, the length of the flow channel, between two parallel surfaces, is increased, and the clearance can be correspondingly increased. Except for very limited flow through the air escape vent, all of the flow occurs between two parallel surfaces, viz., the piston clearance in relation to the cylinder wall.

The cylinder was made out of a 10-in. length of 2-in. stainless steel sanitary tubing. In use it was filled uniformly to a height of 21 cm. Piston travel was timed through a distance of 10 cm. by sighting the passage of suitably placed marks on the stem in relation to the top of the stem guide. The position of the

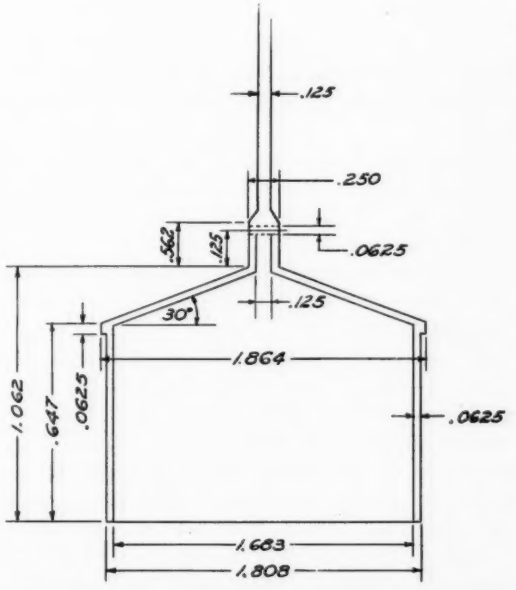


FIG. 2. The plunger of the modified Gardner Mobilometer.

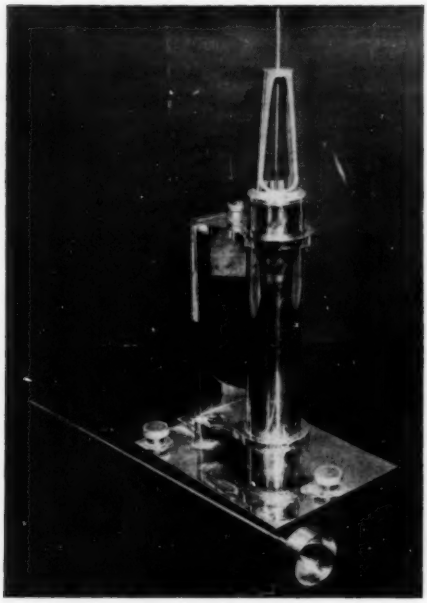


FIG. 3. The modified Gardner Mobilometer.

marks was established to allow at least 5 cm. travel for acceleration before starting the timing and to terminate the timing 2.5 cm. from the bottom to avoid a possible "end effect."

Procedure, standardizing the instrument. To standardize the instrument so that timing observations can be translated into viscosity units, it was necessary to determine the flow rate of a liquid of accurately known viscosity, using an accurately known applied force.

For solutions of known viscosity, sucrose solutions are conveniently used, referring to detailed tables that have been published for this purpose by the U. S. Bureau of Standards *(2)*.

The applied force is the total weight of the traveling parts minus the buoyant force of the displaced liquid. During a measurement the piston is completely immersed, but the stem immersion varies. Accordingly, the volume of the piston and stem is to be determined to a point midway between the immersed stem length at the start and at the end of the timing interval. The displacement volume to this point can be most conveniently determined by weighing the piston and stem *(a)* suspended in air, and *(b)* suspended in water to the selected point on the stem. A torsion balance, accurate to 0.01 g., is suitable for this purpose. The difference between *a* and *b* in grams, divided by the density of the water in grams per cubic centimeter represents the displacement in cubic centimeters.

The instrument used in this study was calibrated in accordance with the above principles, and the essential data are as follows:

Weight of piston and stem in air	71.32 g.[5]
Weight of piston and stem [6] in water, 35° C.	63.79 g.[5]
Weight of water displaced	7.53 g.
Density of water at 35° C.	0.99403 g./cc.
Volume of water displaced	7.58 cc.

[5] Net weight, i.e., corrected for the weight of the suspension wire used in connection with the weighings.

[6] Immersed to the selected point on the stem as explained.

Therefore, the effective force (in grams) employed in timing the descent of the piston through the liquid in the cylinder is:

71.32 – (7.58 × the density of the liquid in g./cc.).

If the pan and weights are applied at the top of the stem, their weight is added directly to the effective force.

The constant *(k)* for the instrument was determined by utilizing a 60% sucrose solution at temperatures shown in Table 1, proceeding as directed below for viscosity measurement. The instrument constant *(k)* reflects the piston clearance and the distance of travel. With these factors fixed, the time *(t)* in seconds will be directly proportional to the viscosity of the liquid *(n)* in centipoises, and inversely proportional to the effective force *(f)* in grams. Thus, the relationship can be expressed by the formula $kt = n/f$. The fixed factors are therefore taken into consideration through the instrument constant *(k)*.

With n and f known, and with t determined by experimental observations, k can be computed by means of the preceding formula. The data pertaining to the determination of the instrument constant are presented in Table 1. The five found values for the instrument constant are in satisfactory agreement; their average value is 0.01318.

Procedure, viscosity measurement. The cans of evaporated milk were placed

TABLE 1

Determining the instrument constant for the modified Gardner Mobilometer

Solution	Bureau of standards values[a]		Calculated effective force[b]	Observed time[c]	Instrument constant
	Viscosity	Density			
	(cp.)	*(g./cc.)*	*(g.)*	*(sec.)*	
60% sucrose solution, 5° C.	156.0	1.29334	61.516	190.76	0.01329
60% sucrose solution, 10° C.	109.8	1.29114	61.533	134.12	0.01330
60% sucrose solution, 20° C.	56.5	1.28640	61.569	70.26	0.01306
60% sucrose solution, 25° C.	43.86	1.28396	61.588	53.86	0.01322
60% sucrose solution, 35° C.	26.52	1.27876	61.627	32.98	0.01305

[a] The values were converted to g./cc. by multiplying by 0.999973.

[b] Weight of piston and stem, 71.32 g.; displacement volume, 7.58 cc.

[c] The observed time represents the mean of 5 determinations in each case.

in a water bath at the chosen temperature [7] for 1 hour. The viscosity stand and cylinder also were placed in the water bath and the leveling screws were adjusted so that the stand was level and the cylinder was perpendicular. Each can was opened just prior to the viscosity test, and the contents were transferred to the cylinder with a minimum of agitation. The piston was inserted to such depth as to eliminate the air pocket from the hollow piston, allowing the air to escape through the vent for that purpose. The stem guide was then placed into position. With the eyes on a level with the upper surface of the stem guide, the piston was released and its time of descent was determined by sighting the stem marks in relation to the guide.

The observed time in seconds was converted to centipoises by substituting the proper values for f, k, and t in the formula: $n = fkt$.

In using this procedure with the sucrose solution, or any other fluid that exhibits true viscous flow, replicate determinations can be made with the same cylinder contents. This cannot be done, however, with evaporated milk; repeat determinations lead to successively lower readings, apparently because structures are being disrupted.

EVALUATION OF METHODS

Homogenization effectiveness test. The centrifugal procedure was evaluated by applying it to unconcentrated, homogenized milk with known admixtures of unhomogenized milk and to milk that had been homogenized at different pressures. Typical results are given in Table 2. The procedure also was evaluated in relation to evaporated milk manufacture, and these findings are reported in connection with the gravity fat separation and viscosity determinations in Table 3.

The results demonstrate that the procedure, as outlined above, will detect small admixtures of unhomogenized milk or small differences in the thoroughness of homogenization. These results were obtained with the fat contents measured by the Babcock test; greater precision probably could be achieved by using gravimetric fat determinations.

Composite evaluation of the tests. To evaluate the homogenization effectiveness test in conjunction with the viscosity test in relation to the gravity fat separation test, the three tests were applied to 27 samples of evaporated milk from the commercial operations of five different evaporated milk plants. For each sample one can of unsterilized milk and three cans of the same milk after sterilization were obtained. The homogenization effectiveness test was applied to the unsterilized product, diluted with an equal volume of water; one can of the sterilized product was used for the viscosity determination, and the other two cans were stored for the gravity fat separation test in duplicate. The results are given in Table 3.

[7] In this study the viscosity of evaporated milk samples was measured at 37.78° C. (100°F.) using a piston and stem weight of 71.32 g., and assuming the density of the samples to be 1.06. The effective force was 71.32 — (7.58 × 1.06) or 63.285 g. Because the effective force (f) was considered to be constant from sample to sample, this factor was consolidated with k; $fk = 63.285 \times 0.01318$ or 0.834. Thus, $n = 0.834 \times t$.

TABLE 2

The sensitivity of the homogenization effectiveness test

Description of milk sample	Fat content of top 10 ml.		Homogenization effectiveness (% enrichment)
100 ml. homo. milk[a]	5.1	5.1	47.8
98 ml. homo. milk + 2 ml. unhomo. milk[b]	5.5	5.6	60.7
96 ml. homo. milk + 4 ml. unhomo. milk	5.8	5.8	67.8
94 ml. homo. milk + 6 ml. unhomo. milk	6.0	—	73.5
Milk[a] homogenized at 1,750 psi.	5.1	5.2	49.3
Milk homogenized at 2,000 psi.	4.8	4.7	37.7
Milk homogenized at 2,250 psi.	4.6	4.6	33.3
Milk homogenized at 2,500 psi.	4.4	4.4	27.5

[a] Fat content 3.45%
[b] Fat content 3.6%

TABLE 3

Gravity fat separation in evaporated milk in relation to the homogenization effectiveness and viscosity tests

Sample No. and Plant No.	Gravity fat separation	Homogenization effectiveness (% enrichment)	Viscosity *(cp.)*	HE/V[b]
1 – 3	1.7	17.4	30.0	0.58
2 – 3	2.0	19.3	27.4	0.70
3 – 5	2.1	20.6	40.7	0.51
4 – 4	2.3	19.3	37.0	0.52
5 – 4	2.5	26.3	39.9	0.66
6 – 5	2.8	21.8	37.4	0.58
7 – 2	3.2	22.5	26.9	0.84
8 – 3	3.8	12.4	22.9	0.54
9 – 2	3.9	21.2	22.3	0.95
10 – 1	4.3	30.0	31.8	0.94
11 – 5	5.1	18.7	40.9	0.46
12 – 1	6.6	23.1	22.1	1.04
13 – 5	7.2	21.8	25.0	0.87
14 – 1	8.8	32.6	23.4	1.39
15 – 1	10.0	23.4	20.5	1.14
16 – 3	10.2	25.0	18.1	1.38
17 – 3	10.6	22.5	15.3	1.47
18 – 2	11.8	21.7	15.3	1.42
19 – 4	13.7	31.3	17.6	1.78
20 – 4	18.1	28.8	11.9	2.42
21 – 2	19.8	23.7	14.7	1.61
22 – 4	23.5	29.6	13.8	2.14
23 – 1	26.8	46.4	14.7	3.16
24 – 3	30.5	24.4	10.8	2.26
25 – 2	37.5	24.4	9.0	2.71
26 – 1[a]	76.9	70.5	9.8	7.19
27 – 1[a]	124.0	106.0	9.2	11.50

[a] Specially prepared samples.
[b] Homogenization effectiveness rating divided by viscosity.

These data show that there is less gravity fat separation in the samples with a high viscosity. Likewise, there is less gravity fat separation as the effectiveness of homogenization is increased, obtaining a lower homogenization effectiveness rating.

Since the rate of gravity fat separation is directly related to the size of the

fat globules and inversely related to the viscosity of the suspending medium, these latter terms should somehow be combined. This may be accomplished by dividing the effectiveness of homogenization by the viscosity of the sample. Thus, a fourth term is obtained and this figure is directly related to the extent of gravity fat separation. This relationship is positive and is linear over the range of samples in this trial. The precision of the relationship between fat separation and the term reflecting homogenization effectiveness and viscosity can best be expressed by the statistical term coefficient of correlation. The data in Table 3 show a positive coefficient of correlation of 0.989.

DISCUSSION

It is logical to expect that the general phenomenon of fat separation can be viewed in light of the fundamental concepts relating to the rise of fat particles in unconcentrated milk. This permits the division of the problem into a number of separate entities, e.g., viscosity, size of the fat particles, and the density difference between the fat particles and the suspending medium. It is then necessary to adopt or devise methods for measuring the individual factors which can be related to the general phenomenon. For example, the rate of rise of the individual fat particles (likewise fat separation) would be directly related to the square of the radii of the fat particles.

From the theoretical standpoint the size of the individual fat particles is of interest, but from a practical standpoint the interest is primarily in the combined effect of the various sizes. The total effect of the various sizes will determine the extent of fat separation.

The total effect of the various sizes is the basis of the methods developed in this work for effectiveness of homogenization and gravity separation. This may be explained by the following reasoning: The sample to be tested is in a container of fixed height and the quantity removed from the upper layer is equivalent to a fixed height, or a fixed proportion of the total sample. The size of the fat particles influences the rate at which they travel. For example, a $2\,\mu$ fat particle would travel x distance under the conditions of the experiment, and a $6\,\mu$ fat particle would travel $9x$ distance, since the rate of travel is directly proportional to the square of the radius. Thus, the larger globules would travel a greater distance, and a greater number would travel from the lower section to the upper section to be removed in the sample for enrichment. It therefore follows that the tendency for enrichment is directly related to the size of the particles. On the basis of this reasoning, the previously described tests are fundamentally sound and measure the tendency for concentration in the upper layer, reflecting practical conditions.

The general phenomenon involves another factor, viscosity, which may be isolated and measured. The importance of viscosity can be determined by its influence on the rate of rise of the individual globules or the over-all problem of fat separation. With our present knowledge, however, the effectiveness of the method for measuring viscosity can be evaluated only in terms of the other tests, as a total relationship.

The over-all evaluation of methods using commercial samples showed a good correlation between gravity fat separation and the combined value for effectiveness of homogenization and viscosity. These results substantiate the efficacy of the methods and establish the relative importance of the individual factors of the general problem of fat separation.

SUMMARY

The problem of fat separation in evaporated milk can be divided into at least three factors. The extent of fat separation is inversely related to the viscosity, directly related to the square of the radii of the fat particles and directly related to the density difference between the fat particles and the suspending phase.

A suggested procedure is given for determining the effectiveness of homogenization. This method is based on the total effect, or the result of the rate of travel, of the fat particles. Extending the same logic, a method is given for determining the extent of gravity fat separation during storage. In addition, the procedure and description are given for a modified Gardner Mobilometer as a means of measuring viscosity.

These methods were applied to samples of commercially prepared evaporated milk, and the correlation between the tests was highly significant.

ACKNOWLEDGMENTS

This work was financed in part by a grant from the Carnation Company.

REFERENCES

(1) Baldeschwieler, E. L., and Wilcox, L. Z. Determination of High Viscosities by Means of the Gardner Mobilometer. *Ind. Eng. Chem.*, Anal. Ed., 11: 525. 1939.

(2) *Bulletin of the Bureau of Standards.* Government Printing Office, Washington, D. C., p. 86, Appen. B. 1918-19.

(3) Deysher, E. F., Webb, B. H., and Holm, G. E. The Viscosity of Evaporated Milks of Different Solids Concentrations. *J. Dairy Sci.*, 27: 345. 1944.

(4) Hostettler, H., Rychener, Elizabeth, and Künzle, Lilly. Untersuchungen über das in der Kuhmilch in nativem (Genuinum) Zustand Vorliegende Kasein. *Landwirtsch. Jahr. Schweiz*, 63: 31. 1949.

(5) Rahn, O., and Sharp, P. F. *Physik der Milchwirtschaft.* Verlagsbuchhandlung Paul Parey, SW 11, Hedemannstrasse 28 u. 29, Berlin. 1928.

(6) Snyder, W. E., and Sommer, H. H. Quick Test for Homogenized Milk. Wis. Agr. Expt. Sta., *Bull.* 456. 1942.

(7) Troy, H. C., and Sharp, P. F. Physical Factors Influencing the Formation and Fat Content of Gravity Cream. *J. Dairy Sci.*, 11: 189. 1928.

THE ANALYSIS OF ERRORS IN ASSAYING FECAL ANDROGENS IN THE DAIRY COW [1]

A. GRANDAGE, R. B. CASADY,
AND H. L. LUCAS
Institute of Statistics and Department of Animal Husbandry
North Carolina State College, Raleigh

Since Riley and Hammond *(9)* first reported on the androgenic activity of cow feces, one of the principal methods of biological assay of this activity has been the chick comb response, using dried feces as 10% of the chick diet. Results have been expressed in terms of the per cent increase in the comb weight of the test birds over that of controls, or as milligrams comb weight per 100 g. body weight. Recent studies at the University of California and North Carolina State College have indicated that responses expressed in this manner are dependent on the length of assay period and breed of chick used, as well as the usual variations between chicks and cages of chicks on the same diet. Therefore, it has been difficult to make comparisons between results obtained by different investigators or to determine whether the differences are real.

The purpose of these studies was to assess the errors in estimation of the potency of fecal androgens where assayed by means of oral administration to the chick, and to study means of reducing such errors.

METHODS

Procurement of data. The data were obtained by determining the comb response of chicks to cow feces incorporated as a certain per cent of a basal ration, or by adding known amounts of crystalline methyl testosterone to the basal diet in conjunction with inactivated feces. Day-old White Leghorn and New Hampshire cockerels were used with feeding periods of 14 and 21 days. Only data from cockerels were included, the pullets found at autopsy being discarded. On autopsy the comb was removed as described by Frank *et al. (8)* and weighed on a torsion balance to the nearest 0.2 mg. Feed consumption and body weight were ascertained at the time of autopsy.

The basal chick ration was a well-balanced diet furnished by the Poultry Divisions of the University of California and North Carolina State College. When feces were added to this basal ration, they were handled as previously reported *(2)*.

The chicks were kept in brooders with the temperature under the hover pad at 100 to 105° F. The room temperature was maintained at approximately 70° F.

The assays used were standard six-point and four-point designs with at least two replications as described by Emmons *(6)*, Finney *(7)*, and Bliss *(1)*. These

Received for publication August 3, 1953.

[1] Approved for publication as Paper No. 497 in the Journal Series of the North Carolina Agricultural Experiment Station.

designs make use of three- and two-dose levels, respectively, of both standard and unknown. The nine assays reported utilized from 70 to 100 chicks each with 4, 5, or 10 chicks per cage. The standard preparation used was crystalline methyl testosterone and the unknown consisted of feces from cows of the college herds. In order to standardize the ration fed, the active feces and standard preparation were diluted with inactive feces so that all groups of chicks were fed a diet containing the same percentage of feces, whether wholly active, part active and part inactive, or wholly inactive. In this manner effects of unknown factors in the feces and the dilution effect of feces added to the feed were equalized for all groups.

Preliminary to the actual assay studies, dose response curves were determined using various levels of methyl testosterone in the diet.

Analyses. In this study it was desirable to compare not only preparations tested together but also preparations tested at different times and/or places. In the first instance when it was necessary to test merely the hypothesis that the several preparations were alike in activity, it was sufficient to divide the test chicks into several groups and to assign the preparations (feces) to the groups at random and proceed with the test. The only statistical problems encountered in this instance were to determine how many animals were required to give a desired accuracy, how many groups of animals should be assigned to each preparation, and how many animals should be in each group in order to obtain the most efficient design of the test *(3)*.

Tests conducted in the above manner were adequate for comparing preparations from different cows or comparing preparations treated by different methods, but it did not afford the possibility of comparing preparations run at different times or places, since the level of response of the test animals varies from time to time and from place to place. Therefore, since such comparisons were desired, a standard substance was used at each testing so that relative potencies could be computed. In this type of test, consideration must be given to the choice of a suitable standard substance. The choice of a preparation to be used as a standard is relatively simple when the active principle is known. However, when the active substance has not been identified, as is true of the androgenic factor in the feces of dairy cows, the choice of a standard is difficult. Many times a preparation which is from the same source as the unknown can be utilized safely as a standard if it is stable, plentiful, and of sufficient potency. This could have been done in the present investigations by pooling a large quantity of dried fecal material known to contain the androgenic factor. However, if this were done, comparison of results by different investigators would be difficult unless each investigator had access to the same standard preparation. Therefore, it was decided to try methyl testosterone as the standard. Preliminary work done at the University of California indicated that the log dose-response curve for methyl testosterone was approximately linear and that the responses to log doses of fecal material gave a line essentially parallel to the line obtained using methyl testosterone. In addition, the nine assays conducted at North Carolina State College indi-

cated that there were no significant departures from parallelism. Thus, it was concluded that methyl testosterone could serve as a suitable standard.

Whether simple comparisons or potencies are desired, it is necessary to know the variance of an observation and certain features of the design of the test if the size of the test necessary to obtain a specified accuracy is to be determined. The data accumulated in this series of experiments were used to explore the possibility of reducing the variability of such estimates by use of concomitant variables (i.e., body weight, food intake, etc.) and to estimate the size of the variability so that future experiments could be planned adequate in size to meet specified accuracy requirements. This was accomplished by analyzing the variables (body weight, comb weight, comb weight divided by body weight, and comb weight divided by the square of body weight) by analysis of variance methods. Also analyses of covariance were used to adjust comb weight for body weight, comb weight for the square of body weight and comb weight divided by body weight for feed consumption. From these analyses coefficients of variation and logarithmic coefficients of variation were computed. The logarithmic coefficient of variation is the ratio of the standard deviation to the slope of the dose response line *(4)*.

The essential part of the analysis of variance, with the expected values of the mean squares, is as follows:

Source of variance	*d.f.*	*Expected mean square*
Between treatments	$t-1$	$\sigma^2 + p\sigma_p^2 + \frac{N}{t}\sigma_t^2$
Between pens treated alike	$\frac{N}{p} - t$	$\sigma^2 + p\sigma_p^2$
Within pens	$\frac{N}{p}(p-1)$	σ^2
Total	$N-1$	

where there are t treatments, p animals per pen and a total of N animals. The variance between animals from the same pen and treatment is indicated by σ^2, σ_p^2 represents the component of variance due to the difference between pens and σ_t^2 represents the component of variance due to differences between treatments. Consideration of the expected mean squares indicates that the between-pens mean square is the proper error to test treatments if σ_p^2 exists *(10)*. Notice that if there is only one pen of chicks per treatment, there is no estimate of error to test treatment differences, since the within-pens mean square does not contain a component due to pens as does the treatment mean square. However, if the between-pens component is zero, both the within-pens mean square and the between-pens mean square estimate σ^2 and may be pooled to form the proper error to test treatment differences.

TABLE 1

Averages of the coefficient of variation, logarithmic coefficient of variation and ratio of the between pen to within pen components of variance, based on the nine assays analyzed by various methods

Analysis	C.V.[a]	λ[b]	σ_p^2/σ^2[c]	Lower limit	Upper limit
Comb weight (CW)	40.2	0.479	1/12	1/549	1/6
Body weight (BW)	14.3	1.732	1/13	–1/1668	1/6
CW/BW	34.1	0.374	1/26	–1/36	1/8
CW/(BW)^2	32.3	0.338	1/39	–1/27	1/10
CW adjusted for BW	33.0	0.350	1/36	–1/28	1/9
CW adjusted for (BW)^2	33.1	0.357	1/31	–1/30	1/9
CW/BW adjusted for feed consumption	34.2	0.354	1/387	–1/15	1/11

[a] Coefficient of variation from between pens mean square on a per chick basis

$$= \sqrt{\frac{\text{between pens mean square}}{\text{grand mean}}} \times 100$$

[b] Logarithmic coefficient of variation from between pens mean square

$$= \sqrt{\frac{\text{between pens mean square}}{\text{slope log-dose response line}}}$$

[c] Between pen to within pen component of variance ratio with 95% confidence intervals. These ratios and their limits were computed using the formula,

$$k\left(\frac{F}{F_{0.975}} - 1 < \frac{F}{E(F)} - 1 < \frac{F}{F_{0.025}} - 1\right)$$

Where F is obtained by pooling the sums of squares and degrees of freedom from the nine assays, $F_{0.975}$ and $F_{0.025}$ are the tabular values of Snedecor's F, $E(F)$ is the expected value of F and k is the average value of the coefficient of σ_p^2.

RESULTS AND DISCUSSION

The results of the analyses of variance and covariance are summarized in Table 1. The ratio of the between-pen to within-pen components of variance indicated that σ_p^2 was about one-twentieth σ^2. However, if p is large, i.e., if the number of chicks per pen is large, the term $p\sigma_p^2$ becomes important even though σ_p^2 is small. For example, if σ_p^2 is one twentieth σ^2, and 10 chicks are used per pen, the average mean square for between pens, $\sigma^2 + p\sigma_p^2$, would be 50% larger than the within-pens mean square. Consequently, if the within-pens mean square, σ^2, was used as error, the treatment differences would be declared significant too often, not only because the error was too small but also because the degrees of freedom were too large.

Since the between-pens mean square is the proper error variance for testing treatment differences, the coefficients of variation given have been determined from the between-pens mean squares. It should be noted that for the same reason it is desirable to have as many degrees of freedom as possible associated with pens. This can be accomplished by using several small pens rather than one large pen per treatment so that as many pens as possible may be assigned to each prepara-

tion. Ideally, and except for expense and labor, one chick per cage would be used. It was found convenient to use five chicks per pen in these assays.

Simple comparisons. When an experiment is planned merely to make comparisons between different preparations, an estimate should be made of the size of the experiment required. If Student's $t_{0.05}$ is assumed to be 2 a rough approximation can be found from the equation, $n = \left(\frac{4\ c.v.}{d}\right)^2$, where n is the number of pens of chicks required per treatment mean, *c.v.* is the coefficient of variation of a pen mean, and d is the desired 5% least significant difference ($LSD_{0.05}$) expressed as per cent of the mean.

Since the coefficients of variation in Table 1 are on a per chick basis, and there were five chicks per pen, they must be divided by $\sqrt{5}$ to give the coefficient of variation of a pen mean. If other numbers of chicks per pen are to be used, the coefficient of variation per chick will have to be reconstructed using estimates of σ^2 and σ^2_p i.e. if p chicks are used per pen the coefficient of variation on a per chick basis is $\frac{\sqrt{\sigma^2 + p\sigma^2_p}}{\text{grand mean}} \times 100$. For instance, if the coefficient of variation is 30% on a per chick basis, (approximately true for comb measurements in these experiments) and the $LSD_{0.05}$ desired is 20% of the mean, seven pens of five chicks each per treatment mean will be required. A more accurate method of determining n is given by Cochran and Cox, *(3)*.

It can be seen from Table 1 that utilizing body weight as a covariable reduced the coefficient of variation about 5 to 7% and the logarithmic coefficient of variation *(λ)* from 0.48 to about 0.35. The addition of feed intake as a covariable had little or no effect on the coefficient of variation or the logarithmic coefficient of variation.

Any small advantage gained by using covariance techniques as opposed to using ratios such as comb weight per 100 g. body weight was generally offset by the loss of a degree of freedom in error. If the degrees of freedom associated with error were large enough, e.g., 16 or more, the use of covariance adjustments can be expected to give a 2 or 3% greater reduction in the coefficient of variation than the use of ratios. In one assay, measurements of comb length and comb height at 1 week were used as a covariate but were found to be of no value in reducing the variation. In spite of the fact that experiments at the University of California (Table 2) indicated that adjusting for body weight squared sometimes increased the variation accounted for by regression as much as 12% over adjusting for body weight, little or no advantage was evident in subsequent assays (Table 1).

The coefficients of variation and logarithmic coefficients of variation for comb weight unadjusted, the breeds of chick used, and the durations of test are presented in Table 3 for each of the several assays. On the basis of these coefficients of variation, there is little choice between the breeds or durations of assay period. Although the White Leghorns gave greater responses than the New

TABLE 2

Multiple correlation coefficients fitting various functions of body weight and comb weight

Function fitted	White Leghorns	New Hampshires	Per cent variation accounted for by regression	
			W.L.	N.H.
Linear ($y = a + b_1x$)[a]	0.8154	0.9077	66	82
Quadratic term alone ($y = a + b_2x^2$)	0.8837	0.9226	78	85
Quadratic ($y = a + b_1x + b_2x^2$)	0.8889	0.9364	79	88
No. of chicks[b]	209	59		

[a] y = comb weight, a = intercept, b_i = regression coefficient, x = body weight.
[b] Control birds receiving only a basal ration for a feeding period of 14 days.

Hampshires and 3-week responses were greater than the 2-week responses, these larger responses were sufficiently more variable to render sensitivities about equal.

Assays. The accuracy of an assay is dependent primarily on two factors, the slope of the dose-response curve and the variance. Hence, the logarithmic coefficient of variation (λ) is often used to compare the sensitivity of assays, since λ is the ratio of the standard deviation to slope. One must be careful in making such comparisons, however, to be sure the slope is always computed using logarithms of the doses to the same base in each assay. The logarithm to the base 10 was used in all assays reported here. Comparison of the λ's in Table 1 indicates that the use of body weight as a concomitant variable gave a substantial reduction in λ, although the method by which body weight was introduced did not have any great effect.

Knowing λ does not give sufficient information to compute the required number of observations to obtain a desired confidence interval. The design, i.e., four-point or six-point, etc., the interval between doses, and the potency ratio also are needed to compute the required number of observations. Table 4 gives the number of observations required for selected designs and confidence intervals. The number of observations required was computed using the following formula based on the quarter square of the confidence interval length as used by Finney (7):

$$N = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

where $a = kL^2$

$$b = 8\lambda^2 (L^2 + 8k + 2M^2)$$

$$c = 256\lambda^4$$

and $M = \log R$

$$k = \frac{(\log i)^2}{4} \text{ for a 4-point assay}$$

and $$k = \frac{2(\log i)^2}{3} \text{ for a 6-point assay}$$

where i is the interval between doses, R the potency ratio and L the ratio of the upper confidence limit to the lower confidence limit.

TABLE 3

Variabilities in individual assays using two breeds of chicks and two durations of test

Expt. No.	Breed	Weeks	C.V.	λ
0	NH[a]	2	37	0.47
1	NH	3	31	0.30
2	NH	2	15	0.15
3	NH	2	56	0.53
4	NH	2	74	0.48
5	NH	3	35	0.78
6	WL[b]	3	34	0.77
7	WL	3	43	0.46
8	WL	3	38	0.38

[a] New Hampshire
[b] White Leghorn

In a well planned assay R will be near 1, i.e. the standard and unknown will have approximately equal responses at corresponding high and low dose levels. It can be seen in Table 4 that if R equals 1 and if λ is 0.35, about 350 chicks would have to be used if a confidence interval of $\pm$ 20% is desired. If 100 chicks are used, confidence limits of about $\pm$ 35% are to be expected. In other words when λ is as high as 0.35, large numbers of animals are necessary to establish accurate potencies.

TABLE 4

Number of observations required to obtain 95% confidence limits[a] such that the ratio, L, of the upper limit to the lower limit is $\sqrt{2}$, 2, 4 or 16 for various values of λ and the potency ratio, R[b]

	Logarithmic coefficient of variation (λ)						
L	0.20	0.25	0.30	0.35	0.40	Typical interval	
$\sqrt{2}$	116	181	260	354	463	$0.84 < 1 < 1.19$	
2	31	49	70	95	125	$0.71 < 1 < 1.41$	$R = 1$
4	11	17	24	32	42	$0.50 < 1 < 2.00$	
16	6	10	13	19	25	$0.25 < 1 < 4.00$	
$\sqrt{2}$	159	248	357	486	635	$0.42 < 0.5 < 0.60$	
2	42	66	95	130	170	$0.35 < 0.5 < 0.71$	$R = 0.5$ or 2
4	14	21	31	42	55	$0.25 < 0.5 < 1.00$	
16	7	11	16	22	28	$0.13 < 0.5 < 2.00$	
$\sqrt{2}$	287	448	646	879	1109	$0.21 < 0.25 < 0.30$	
2	75	117	169	229	300	$0.18 < 0.25 < 0.35$	$R = 0.25$ or 4
4	22	34	50	68	88	$0.13 < 0.25 < 0.50$	
16	9	14	21	28	37	$0.06 < 0.25 < 1.00$	

[a] Students $t_{0.05}$ assumed to be 2.

[b] Interval between doses equals 2 for a 6-point symmetrical assay or 3.167 for a 4-point symmetrical assay.

The λ's given in Table 1 apply to assays with pens of five chicks each. If other pen sizes are to be used, λ will have to be recomputed in order to enter Table 4. This can be done using estimates of σ^2 and σ^2_p as was the case for the coefficient of variation.

Perhaps the most significant fact encountered in these experiments has been

the large sampling variation in the data, as indicated by the values of the coefficients of variation *(c.v.)* and logarithmic coefficients of variation *(λ)* in Table 1. Although these values for λ agree favorably with those presented by Dorfman *(5)* for androgen assays using oral administration in the chick, it was felt that this variability and its implications were worth pointing out. If the data of other investigators have been subject to variations as large as were present in these investigations, the interpretation of differences found must be tempered by knowledge of the errors present.

No consideration has been given here to the variation to be expected between fecal samples supposedly from similar sources. This variation would undoubtedly be present and would have to be added to the assay variability when testing the effects which various treatments of animals or of feces may have on the androgenic content of fecal material.

SUMMARY AND CONCLUSIONS

Nine assays of androgens in feces from dairy cows, involving the comb response to oral administration in chicks, were conducted to assess the errors in estimation of androgenic potency and study the means of reducing such errors.

Analyses of variance and covariance were performed on comb weight, body weight, comb weight divided by body weight, comb weight divided by body weight squared, comb weight adjusted for body weight, comb weight adjusted for body weight squared, and comb weight divided by body weight adjusted for feed consumption. From these analyses estimates were obtained of the coefficients of variation, logarithmic coefficients of variation and the ratio of the between-pen to within-pen components of variance.

Results indicated that large sampling variations and significant between-pen effects must be considered in assays of this type. The error was reduced by the use of body weight as a covariable with comb weight, irrespective of how it was introduced, but body weight squared appeared to be more efficient than body weight alone. The use of body weight reduced the coefficients of variation for comb weight alone from 40% to approximately 33% and reduced the logarithmic coefficient of variation from 0.48 to approximately 0.35. Reductions of this magnitude make appreciable differences in the number of observations required. Other covariables, such as feed consumption and comb measurements, had little effect on reducing the error after body weight had been considered.

The data presented suggest that for simple comparisons the following procedures are desirable:

1. Use a total number of chicks per preparation as determined by the coefficient of variation of the method used and by the desired L.S.D.
2. Use small pens per preparation to increase the degrees of freedom associated with pen differences.
3. Use the between-pen mean square as error.
4. Adjust comb weight for final body weight squared, either by covariance or by ratio.

The recommendations for planning assays are similar to those for simple comparisons except that perhaps larger numbers of animals will be required and that very careful attention will have to be paid to dose levels of the standard and unknown so as to make them as equal in response as possible.

ACKNOWLEDGMENTS

The authors wish to express their appreciation to H. H. Cole and G. E. McDaniels of the University of California at Davis for their aid in preliminary studies leading to this work.

REFERENCES

(1) Bliss, C. I., in Paul György. *Vitamin Methods.* Academic Press, New York. 1951.
(2) Casady, R. B., Cole, H. H., and Hart, G. H. Factors Modifying the Excretion of Fecal Androgens in the Cow. *J. Dairy Sci.*, **32**: 265. 1949.
(3) Cochran, W. G., and Cox, G. M. *Experimental Designs.* John Wiley and Sons, Inc. New York. 1950.
(4) Coward, K. H., Dyer, F. J., Morton, R. A., and Gaddum, S. H. The Determination of Vitamin A in Cod-liver Oils. *Biochem. J.*, **25**: 1102. 1931.
(5) Dorfman, R. I., in C. W. Emmons. *Hormone Assay.* Academic Press Inc., New York. 1950.
(6) Emmons, C. W. *Principles of Biological Assay.* Chapman and Hall, Ltd., London. 1948.
(7) Finney, D. J. *Statistical Method in Biological Assay.* Charles Griffin and Co., London. 1952.
(8) Frank, R. T., Klempner, E., Hollander, F., and Kriss, B. Detailed Description of Technique for Androgen Assay by the Chick Comb Method. *Endocrinol.*, **31**: 63. 1942.
(9) Riley, G. M., and Hammond, J. C. An Androgenic Substance in Feces of Cattle as Demonstrated by Tests on the Chick. *Endocrinol.*, **31**: 653. 1942.
(10) Snedecor, G. W. *Statistical Methods.* 4th ed. The Iowa State College Press, Ames. 1946.

SOME NUTRITIONAL REQUIREMENTS OF BOVINE RUMEN BACTERIA [1]

J. J. McNEILL, R. N. DOETSCH, AND J. C. SHAW
Departments of Bacteriology and Dairy Husbandry
University of Maryland, College Park

During the course of nutritional investigations of bacteria from the bovine rumen, it has become evident that rumen fluid is an indispensable constituent of any medium used to cultivate maximum total numbers of these bacteria. The rumen fluid requirements of pure cultures of rumen bacteria have been noted by Hungate *(10)* and Bryant *(2)* and indirectly by Burroughs *et al. (4)*. In this laboratory, Doetsch *et al. (5)* also have reported that bacteria cannot be cultured from higher dilutions of normal rumen fluid if rumen fluid is omitted from a standard medium used for making counts. The purpose of this work was to obtain information that would reveal the nature of the essentiality of rumen fluid. Such information, although concerned more directly with the metabolism and physiology of the bacteria within the rumen, would also have important implications with respect to the nutrition of the animal itself, since cow and bacteria are so intimately related.

Rumen fluid is a mixture of bacteria, protozoa, plant fragments, soil, and many chemical compounds, both substrates and end products, in aqueous solution and suspension. In order to eliminate inconsistencies that might arise from using such variable material, experiments were devised that might reveal the function of rumen fluid in the stimulation of bacterial growth. This was attempted by looking for better defined and more readily available materials capable of the same stimulation. The ultimate objective was an approximate characterization and possible isolation of the active principles.

EXPERIMENTAL

Assay procedure. The following experimental plan was employed. A sample of rumen fluid was obtained, and one portion was used immediately to prepare a standard rumen fluid agar medium. With some modifications *(5)* this medium is essentially the same as that of Hungate *(10)* and will be referred to throughout this paper as the standard medium. Another portion of the rumen fluid sample was subjected to various treatments and extractions in an attempt to effect an isolation of the active principles. These preparations then were used in the standard medium in place of fresh rumen fluid.

In addition, still other lots of the standard medium were made, omitting rumen fluid entirely, and in its place using many of the nitrogenous sources and stimulatory extracts which are employed in the cultivation of nutritionally

Received for publication August 3, 1953.

[1] Paper No. A-431, Contribution No. 2475 of the Maryland Agricultural Experiment Station.

fastidious bacteria. Finally the activity of all these extracts and fractions was estimated. When all media were prepared, another rumen fluid sample was obtained and used as a source of organisms, taking the growth response of the rumen bacteria as an index of the activity of the extracts being tested. This assay method is based on the fact that all media are the same except for the materials being assayed as rumen fluid substitutes, and any variations in response from that observed with the standard rumen fluid medium can be ascribed to the effect of one material alone.

The counting technique for estimation of activity consisted in making dilutions of 10^6, 10^7, and 10^8 of the fresh rumen fluid and inoculating the media contained in roll-tubes *(5)*. After 48 to 72 hours incubation at 39° C., bacterial colony counts were made and the total numbers of rumen bacteria per gram (wet weight) of rumen contents were estimated. The count in the standard medium, usually the maximum, in each experiment was designated as 100%, and the activity of the rumen fluid substitutes is expressed in percentages thereof.

The techniques for obtaining samples, methods of making dilutions, and processing of samples used in this work were the same as previously described by Doetsch *et al. (5)*. An addition to the technique was the use of a solution of cadmium sulfate (5%) and sodium thiosulfate (5%) to remove traces of hydrogen sulfide that are carried over when the carbon dioxide passes through the oxygen absorbent.

Substitution of various nitrogenous substrates and stimulatory extracts for rumen fluid. The following nitrogen sources were used as replacements for rumen fluid: peptone, neopeptone, proteose-peptone, phytone, yeast extract, liver extract, casein hydrolyzate, ammonium sulfate, urea, glycine, aspartic acid, trypticase, and beef extract. All materials were used both singly and mixed and at various concentration levels. In addition, some of these materials were used to supplement the 40% rumen fluid in the standard medium.

Substitution of various rumen fluid extracts and preparations for rumen fluid. Strained, fresh rumen fluid was saturated by addition of ammonium sulfate crystals (approximately 76 g. per 100 ml. rumen fluid). A considerable spongy, brown precipitate was recovered by filtration; the filtrate also was saved. The precipitate was redissolved in distilled water and dialyzed at 5° C. for 24 hours against distilled water to remove residual ammonium sulfate (until a negative test for sulfate was obtained with barium). The filtrate was dialyzed in the same manner and excess water taken up during dialysis was removed by vacuum distillation. Both filtrate and precipitate were incorporated separately in the standard medium to compare the activity of each to fresh rumen fluid.

Rumen fluid was centrifuged at 350 $\times$ g. for 5 minutes to remove larger particles. The supernatant was recentrifuged at 5780 $\times$ g. for 20 minutes, and a heavy precipitate was obtained, which, when stained and examined microscopically, proved to be composed almost exclusively of bacterial cells. The cells were suspended in distilled water and used as a substitute for rumen fluid, as was the supernatant (rumen fluid minus cells).

The growth-stimulating properties of rumen fluid are diminished after 3 to 4

days of storage. In an attempt to preserve rumen fluid, samples were lyophilized immediately upon removal from the rumen. One sample was processed after boiling for one hour to coagulate the protein and other material, and the second was lyophilized without prior heating.

It was necessary to determine that charcoal would decrease the activity of rumen fluid by adsorbing any of the materials required for maximum growth. Rumen fluid was shaken with powdered charcoal (Norite) which had been activated by heating to 260° C. for 3 hours. The charcoal was removed by filtration and the filtrate used in place of fresh rumen fluid. After the effect of Norite adsorption was established, a series of experiments was run to ascertain the optimum pH and Norite concentration for maximum adsorption before any attempts were made to recover the adsorbed constituents by elution methods. Elution experiments were carried out by shaking rumen fluid (1,500 ml.) with 5% Norite at pH 7.0 for 3 hours at 37° C. The carbon was recovered by filtration and dried over calcium chloride in a vacuum oven at 50° C. for 3 hours. The Norite was then divided into 5 portions and each was eluted individually with a different solvent by shaking 3 hours at 20° C. The solvents used were methyl alcohol, 95% ethyl alcohol, diethyl ether, acetone, and a mixture of 25% ammonia in acetone. The carbon was removed by filtration, and the filtrates were concentrated to approximately 20 to 25 ml. by vacuum distillation. These eluates were then assayed in the usual manner.

Samples of rumen fluid were adjusted to pH 11.0 using $N/1$ hydroxide, autoclaved for one hour (121° C.), and readjusted to neutrality with $N/1$ hydrochloric acid, and the effects of this treatment were studied in the usual way. Rumen fluid was also autoclaved for one hour at pH 2.0 and then tested as in the previous experiment.

Rumen fluid filtered through a Seitz filter was used. The filtering process is very slow because the viscous accumulations on the filter pad necessitate frequent changes in order to obtain filtered fluid in quantity sufficient to use in making media.

Since the rumen is an anaerobic organ, the effects of aeration upon the activity of rumen fluid were studied. Air was bubbled through 200 ml. of rumen fluid for 4 hours. In addition, many of the previously described adsorption-elution experiments required the use of controls which permitted observations on the effects of aeration during shaking and filtration.

Comparison of other complete media to the standard medium. As alternatives to rumen fluid agar, carrot-liver infusion medium *(9)*, cystine-trypticase agar *(13)*, and a medium recommended by Gall *et al. (8)* were used in comparison with the standard medium.

RESULTS AND DISCUSSION

The bacterial colony counts in all experiments have been converted to percentage response by designating the count in the standard in each experiment as 100% and expressing the counts in the test media in percentages thereof. The

colony count in the standard medium generally ranged from 50 to 125 $\times$ 10^7 per gram rumen fluid (wet weight).

Nitrogen sources and stimulatory materials. Several of the nitrogenous sources and growth promoting materials are compared to fresh rumen fluid in Table 1. Although it can be seen that many of these substances will support

TABLE 1

Response of rumen bacteria to various nitrogenous sources and stimulatory extracts used as rumen fluid substitutes

Ingredient	Concentration (%)	Response (%)
Peptone	1.0	10[a]
Neopeptone	1.0	17
Proteose-peptone	1.0	25
Phytone	1.0	24
Yeast extract	0.3	20
Liver extract	0.1	28
Casein hydrolyzate	5.0	0
Ammonium sulfate	1.0	0
Urea	1.0	7
Glycine	1.0	0
Aspartic acid	0.5	3
Combinations		
Trypticase, phytone, yeast extract		24
Trypticase, phytone, aspartic acid, pyruvate		3
Trypticase, liver extract		19
Neopeptone, beef extract		11
Carrot-liver infusion, peptonized milk, neopeptone		0
Rumen fluid, urea		81
Rumen fluid, trypticase, phytone, yeast extract		11

[a] Results shown are for those concentration levels giving maximum response.

good growth of most of the nonexacting rumen bacteria, the results shown here demonstrate that none of them possess nearly as much activity for growth of rumen bacteria as does rumen fluid. However, some of these materials (phytone, yeast extract) are stimulatory only for one or two morphological types of bacteria. Apparently other rumen bacteria are inhibited by these nitrogen sources. This is in agreement with the findings of Bryant *(3)* who noted an inhibition in the cellulolytic properties of pure cultures when peptones were added to a 5% rumen fluid medium.

The combination of trypticase, phytone, aspartic acid, and pyruvate was tried, since Doetsch *et al. (7)* found pyruvate to be most vigorously attacked by washed suspensions of rumen bacteria. Sirotnak *et al. (12)* found the same to be true for aspartic acid. It was surprising to find a decreased response when urea was added to the standard medium. Many reports in the literature *(6)* indicate that a considerable proportion of the protein of feed may be replaced by urea. Apparently the utilization of inorganic nitrogen by rumen bacteria depends upon the presence of other, as yet unrecognized, factors.

In Table 2 are shown results of various chemical and physical treatments upon the activity of rumen fluid. The effect of ammonium sulfate precipitation suggests that the importance of rumen fluid as a nitrogen source should not be

TABLE 2

Response of rumen bacteria to various rumen fluid fractions and preparations used as a substitute for fresh rumen fluid

Fraction or preparation	Response
	(%)
Ammonium sulfate precipitated:	
filtrate	19
precipitate	46
Centrifuged:	
rumen bacteria	49
supernatant	52
Lyophilized:	
heated	22
unheated	17
Alkaline autoclaved	75
Acid autoclaved	65
Seitz-filtrate	30
Aerated	100

passed by since the precipitated material retains so much more activity than the filtrate.

The response to bacterial cells and the supernatant of centrifuged rumen fluid is about the same when these fractions are used in the assay medium. This suggests that the proposal of Hungate *(11)* that rumen bacteria themselves contain some material(s) necessary for the over-all rumen population is correct.

The lyophilization process has definite value despite the low activity, because a somewhat refined rumen fluid preparation is thus obtained which supports growth of a wider bacterial spectrum than has been found with other rumen fluid fractions and extracts. In addition lyophilized rumen fluid gives promise as the source of a more stable, convenient, and reproducible starting material than crude rumen fluid.

Heating rumen fluid at pH 11.0 results in a 25% decrease in activity. In addition, many bacteria are able to grow in media made from it. Heating at pH 2.0 destroys most of the reducing capacity and supports the growth of only a few types of bacteria. The majority of colonies in media made with this material are large, filamentous, pale white colonies which when examined microscopically are seen to be long, thin, weakly Gram-positive rods.

The loss of activity due to Seitz filtration was expected in the light of the centrifugation experiment. Since the cells were removed, some loss of activity resulted, and in addition there was the well-known effect of the filter pads in retaining certain materials by ionic attraction and supplying ions to the filtered solutions.

The results of the adsorption and elution experiments are given in Table 3. Adsorption of rumen fluid with charcoal decreased the activity 70 to 85%. The pH optimum was found to be 7.0 and a 5% concentration of Norite was the smallest which could be used for maximum adsorption. When the adsorbed

TABLE 3

Response of rumen bacteria to adsorbed and eluted fractions of rumen fluid samples

Fraction	Response
	(%)
Norite-adsorbed rumen fluid	15-30
Eluates:	
methyl alcohol	4
ethyl alcohol	15
diethyl ether	9
acetone	12
acetone-ammonia	2
Rumen fluid + ethyl alcohol eluate	84

materials were eluted, the ethyl alcohol eluate always gave the highest response. However, when compared to rumen fluid, the activities of all eluates were weak and narrowly selective, stimulating the growth of mainly one morphological type —a large Gram-positive coccus. Addition of an ethyl alcohol eluate to the standard medium resulted in a lower response, as was observed in all cases where the standard medium was supplemented with other materials.

When other complete media were studied *(8, 9, 13)*, it was found that none of them compared favorably with the standard. Under the conditions used in this laboratory, the only medium approaching the standard is a modified Eugon agar *(5)*.

The above results suggest several interpretations. The absence of an appreciable nitrogen source in the standard medium, exclusive of rumen fluid, strongly indicates that rumen fluid functions importantly as a nitrogen source. At the same time, however, rumen fluid must operate as a source of growth factors, some undoubtedly well known, but others as yet unidentified.

The method used is open to certain criticisms. For example, a similar count in two different media does not necessarily mean that all organisms are responding to one or more factors in the same fashion, since it is possible that one factor may result in a high count of certain types, while another factor may be influencing still other distinct groups. In addition, this method does not result in the growth of all bacteria of the rumen, but a sufficient number responds to warrant its use as a preliminary screening technique.

It is also thought that the rumen fluid factors are principally the result of bacterial growth within the rumen since they are not present in the feed prior to ingestion. The failure of various feed preparations and extracts to substitute for rumen fluid *(3)* appears to support this view.

It can be seen from the complexity of the problem and the great variety of bacteria and multiplicity of factors involved that the attainment of further information on the nutritional requirements of rumen bacteria depends upon the development of assay techniques and the application of standard microbiological assay methods with modifications to fit this case. The response of pure cultures of rumen bacteria, an approach which simplifies the problem somewhat,

also is being studied. It must be kept in mind, however, that the requirements of laboratory cultures on artificial media may be different from those of the wild ancestral type. Indeed, the biotype in the wild state may be changed upon laboratory culture. In this regard the studies of Allen *(1)*, on the change of characteristics of bacteria when originally isolated and after several transfers on artificial laboratory media, show that in some instances this is of importance.

SUMMARY

The nutritional requirements of bovine rumen bacteria have been studied with emphasis upon the role of rumen fluid as an essential factor in the growth of these organisms. No materials have been found which possess the same stimulatory effect for the over-all rumen population as does rumen fluid. The essential factors in rumen fluid are not found to any degree in the rich nitrogenous materials ordinarily used for the growth of nutritionally fastidious bacteria. In fact, many of these substances are inhibitory.

Certain complex nitrogenous sources stimulate the growth of a very few types of rumen bacteria, but seem to do so, unfortunately, at the expense of the remainder of the rumen population. Weakly active materials have been extracted from rumen fluid by adsorption-elution methods, but these substances are also selective.

Rumen fluid is considered to be both a source of nitrogen and growth factors when used in media for cultivating rumen bacteria.

ACKNOWLEDGMENT

The authors are indebted to Irby Bunding of the Armour Research Laboratories for supplying the lyophilized rumen fluid used in these studies.

REFERENCES

(1) Allen, M. B. The Thermophilic Aerobic Sporeforming Bacteria. *Bacteriol. Revs.*, **17**: 125. 1953.

(2) Bryant, M. P. The Isolation and Characterization of a Spirochaete from the Bovine Rumen. *J. Bacteriol.*, **64**: 325. 1952.

(3) Bryant, M. P. Personal communication. 1953.

(4) Burroughs, W., Gerlaugh, P., Edgington, B. H., and Bethke, R. M. Further Observations on the Effect of Protein upon Roughage Digestion in Cattle. *J. Animal Sci.*, **8**: 9. 1949.

(5) Doetsch, R. N., Robinson, R. Q., and Shaw, J. C. Techniques Employed in Cultural Investigations of the Bacteriology of the Bovine Rumen. *J. Animal Sci.*, **11**: 536. 1952.

(6) Doetsch, R. N., and Robinson, R. Q. The Bacteriology of the Bovine Rumen. *J. Dairy Sci.*, **36**: 115. 1953.

(7) Doetsch, R. N., Robinson, R. Q., Brown, R. E., and Shaw, J. C. Catabolic Reactions of Mixed Suspensions of Bovine Rumen Bacteria. *J. Dairy Sci.*, **36**: 825. 1953.

(8) Gall, L. S., Stark, C. N., and Loosli, J. K. The Isolation and Preliminary Study of Some Physiological Characteristics of the Predominating Flora of the Rumen of Cattle and Sheep. *J. Dairy Sci.*, **30**: 891. 1947.

(9) Garey, J. C., Foster, E. M., and Frazier, W. C. The Bacteriology of Brick Cheese. I. Growth and Activity of Starter Bacteria During Manufacture. *J. Dairy Sci.*, **24**: 1015. 1941.

(10) HUNGATE, R. E. The Anaerobic Mesophilic Cellulolytic Bacteria. *Bacteriol. Revs.*, **14**: 1. 1950.

(11) HUNGATE, R. E. Kinds of Cellulolytic Cocci in the Rumen of Cattle and Sheep. (Abs.) *Bacteriol. Proc.*, **1952**: 16. 1952.

(12) SIROTNAK, F. M., DOETSCH, R. N., BROWN, R. E., AND SHAW, J. C. Amino Acid Metabolism of Bovine Rumen Bacteria. *J. Dairy Sci.*, **36**: 1117. 1953.

(13) VERA, H. D. A Simple Medium for Identification and Maintenance of the Gonococcus and Other Bacteria. *J. Bacteriol.*, **55**: 531. 1948.

DEGREE OF HERBAGE SELECTION BY GRAZING CATTLE [1]

W. A. HARDISON,[2] J. T. REID, C. M. MARTIN,[3] AND P. G. WOOLFOLK[4]
Department of Animal Husbandry, Cornell University, Ithaca, New York

It is assumed generally that animals graze selectively. Some qualitative indications of selective grazing have been recorded in the literature, but there are available no quantitative data which demonstrate the extent to which it occurs.

In experiments reported in 1749, Hesselgren *(4)* offered hundreds of plant species, both singly and in mixtures, to sheep, cattle, goats, horses, and pigs. Goats and sheep were less, and swine were more, discriminating than the other species studied. No common factor explained the acceptance or refusal of a particular plant by livestock. Plants characterized as "aromatic" were not relished, and it was observed that sheep did not discriminate between poisonous and nonpoisonous plants.

Herbage characteristics associated with selective grazing. The selectivity exercised by grazing animals seems to be influenced by a number of factors associated with the character of plants and the nature of the animal. As a result of direct observation, several workers *(2, 8, 15)* suggested that the degree of selectivity is related to the amount of palatable herbage available. Selectivity was greatest when an abundance of varied herbage existed and decreased as the supply became less. Although young herbage is more nutritious than old forage, Davies *(2)* believed that it was merely a coincidence that sheep preferred plants of an early growth stage. Tiemann and Müller *(17)* found no appreciable correlation between the palatability and nutritive value of herbage grazed by several classes of livestock. The succulence of plants encouraged selection, but harshness and hairiness reduced acceptability *(2)*. Leaves appear to be consumed in preference to stems *(6)*.

The data obtained by Stapledon *(15)* indicate that such factors as the botanical composition of the sward, fertility of the soil, and the quantity of mature, burned or dried herbage may affect palatability and, consequently, influence the amount of selectivity exercised by animals.

Jones *(8)* found that prostrate-growing plants were not selected by animals, probably because of inaccessibility, whereas erect-growing plants were readily consumed. On the other hand, the results of some studies *(7)* have shown that cattle will select leafy herbage in an immature stage of growth, seldom exceeding 4 to 5 in. in height, even when taller herbage is present. Since tall herbage generally is more mature, stemmier, higher in fiber, and otherwise of a somewhat

Received for publication August 7, 1953.

[1] A portion of these data was presented by W. A. Hardison in a thesis to the Graduate School, Cornell University, in partial fulfillment of the requirements for the Ph.D. degree, 1952.

[2] Present address: Virginia Agricultural Experiment Station, Blacksburg.

[3] Present address: Alabama Polytechnic Institute, Auburn.

[4] Present address: University of Kentucky, Lexington.

different physical and chemical composition than shorter herbage of the same species, factors other than height per se may influence animals to graze the shorter herbage.

Some evidence suggesting a relationship of the chemical composition of herbage to animal preferences has been presented. Of herbage grown in the same field, that richest in minerals was reported by Orr *(10)* to have been consumed, while that lowest in these components was refused by grazing animals. Obviously these observations are inconclusive, since the samples of herbage analyzed were assumed to be representative of the herbage actually consumed. Later, Woodman and Evans *(21)* reported that no relationship exists between the mineral content of herbage and its palatability. Apparently the sugar, protein, and vitamin contents of plants do not influence selection in grazing *(11)*.

As a result of their observations of grazing animals and their studies of the composition of hand-plucked herbage samples, Johnstone-Wallace *et al. (6, 7)* concluded that the chemical composition of the herbage available to grazing animals is an unreliable index of the composition of the herbage actually grazed. Tribe's observations *(19)* confirm this conclusion. The findings of Saltonstall *(14)*, Woolfolk *(22)*, and Hobbs *et al. (5)* that the concentration of nitrogen is higher in the feces of grazing animals than in those of animals fed clipped herbage from the same source provide a more objective kind of evidence for selective grazing as well as for the inadequacy of manually sampled herbage. As a result of employing a grazing steer with a ruminal fistula, Saltonstall *(14)* found that the herbage ingested contains more nitrogen than either a clipped or hand-plucked sample. Also, the lower level of lignin in the feces of grazing sheep than in those of sheep fed herbage clipped from the same source suggested to Saltonstall that grazing sheep select portions of the plant which are lower in lignin than the whole, clipped plant. These findings provide indirect evidence that the leafy portion of plants is preferred to the stemmy portion by grazing animals.

With the exception of the data dealing with the composition of ruminal ingesta and feces of grazing animals, the evidence for the effects of various factors associated with the herbage upon the discriminatory grazing tendencies of animals has been obtained by subjective means. However, these observations generally support the idea that the degree of selectivity exercised by animals is influenced by the amount of herbage available. These reports further suggest that the palatability of herbage affects the discriminatory tendencies of animals. Although very little information obtained objectively relates the chemical, physical, or botanical characteristics of herbage to the extent of selection by animals, certain of the observations which have been reported infer that these qualities may influence palatability.

Animal characteristics associated with selective grazing. Certain qualities inherent in animals may contribute to the selection tendency. Johnstone-Wallace *(6)* observed that the senses of sight, taste, and smell appeared to be employed by cattle in the selection of herbage. More recently it was reported that olfaction, because of its adaptive nature, can be of only supplementary importance to

sheep in the selection of herbage *(18)*. Color vision, also, does not appear to influence the grazing behavior of sheep *(20)*. The discriminatory grazing habits of animals have been explained by Stapledon *(16)* on the basis that animals "sense" the need of a particular kind or quality of herbage. In a study of the grazing habits of dairy cows in New Zealand, Hancock *(3)* found that certain sets of monozygotic twins were more discriminating grazers than others while both members of a given set of twins selected herbage to about the same degree. These observations suggest that certain characteristics inherent in animals influence the selectiveness exercised in grazing.

The ability of animals to select herbage of high nutritive value would seem to have economic importance. However, it has not been determined whether highly discriminating grazers consume more or less of total nutrients than less selective grazers. Hancock *(3)* pointed out that the highly selective grazing animal may not perform as well as an unselective grazer when herbage is scarce.

The objects of this investigation were to determine: *(a)* the nature of the herbage diet selected by grazing steers, *(b)* the extent to which growing steers select herbage under free- and restricted-grazing conditions, *(c)* the relationship of selectiveness to total nutrient intake, and *(d)* the consistency with which animals graze discriminately.

EXPERIMENTAL PROCEDURE

The basic design employed in this investigation was the same for all forages examined and trials conducted. One group of steers was allowed to graze herbage from the same source as, though in an area adjacent to, that which was clipped and hand fed to a similar group of stall-confined steers. The grazing and hand-feeding trials were conducted simultaneously. Both groups (hand-fed and grazing) theoretically had access to the same herbage. No supplemental feeds were fed during any of the trials.

Animals composing the hand-fed and grazing groups received herbage from the same pasture continuously throughout the season or period during which a particular pasture was being examined. Areas of various sizes were grazed during periods of varying lengths. Consequently, the herbage available on each succeeding area grazed within a given pasture was more mature than that on the preceding one, except in the cases in which aftermath herbage was studied.

A series of digestion trials was conducted with each of four mixed-pasture herbages and two relatively pure swards at three or more stages of growth. Total collections of feces were made from both groups of steers by means of fecal-collection bags. The steers in the hand-fed groups received measured amounts (constant for a given trial) of herbage, and digestibility was determined in the conventional manner. The chromogen concentration of the feces was employed to estimate the amount and digestibility of the dry matter consumed by the grazing steers *(13)*. During the preliminary periods, an attempt was made to regulate the intakes of the hand-fed steers to a level that would result in a minimum of refused herbage during the digestion trials. The hand-fed herbage was clipped at a stubble height of approximately 2 in.

CONDUCT OF TRIALS

1949 trials. Three consecutive digestion trials were conducted with a mixture of forage consisting largely of timothy and Kentucky bluegrass during the period, May 18 to June 25, 1949.

Herbage in the vegetative, boot-to-early-head, and full-bloom stages of timothy growth were examined in Trials 1, 2 and 3, respectively. Sixteen- and 15-day periods intervened Trials 1 and 2 and Trials 2 and 3, respectively. The hand-feeding and grazing digestion trials were conducted simultaneously, with 7- to 12-day preliminary feeding periods preceding the hand-feeding trials.

Three steers (two Holsteins and one Hereford) composed each of the grazing and hand-fed groups employed in Trials 1 and 2. Although the hand-fed group consisted of the same three steers in Trial 3, the grazing group was composed of two animals (one Holstein and one Hereford) because of damage to the fecal-collection harness on one steer. The weights of the six steers at the beginning of the experiment ranged from 336 to 438 lb.

An attempt was made to regulate the size of the area alloted to the grazing steers so that within a 4-day period the herbage would be grazed down to a level approximately the same as that of the adjacent area which was being clipped for the hand-fed animals. Although this was not accomplished, it resulted in restricted grazing of areas of approximately 400 sq. yd.

1950 trials. Five consecutive digestion trials with two forage mixtures and four consecutive trials with a third mixture were conducted at 17-day intervals during the period, May 19 to August 17, 1950. Trials 1-4 with Forage 1 and Trials 1-3 with Forages 2 and 3 were conducted with first-growth herbage ranging from vegetative to seed stages of growth. Trials 4 and 5 with Forages 2 and 3 were conducted at successive stages of aftermath growth.

Forage 1 was composed of a mixture of Kentucky bluegrass, timothy, and meadow fescue. Forages 2 and 3 consisted of a mixture of quack grass, timothy, alfalfa, and red clover, with Forage 2 containing a higher proportion of legumes than Forage 3.

Both groups (hand-fed and grazing) of animals were on trial at the same time. The fecal collection periods were of a 4-day duration, and, in the hand-feeding trials, were preceded by a preliminary feeding period of 9 to 13 days. The initial weights of the 18 Holstein steers employed in the 1950 trials ranged from 350 to 570 lb.

The grazing procedure during 1950 was similar to that employed during 1949; areas of approximately 550 sq. yd. were grazed by three steers during periods of 4 to 9 days. Three steers also composed each of the hand-fed groups.

1951 trials. Experiments were conducted with each of two forages during the period, June 6 to August 23, 1951. Forage 1 was relatively pure brome grass, and Forage 2 was composed of a mixture of more than 80% of alfalfa, about 10% of brome grass, and less than 10% of other plants.

Trials 1 and 2 were conducted with each herbage at two uninterrupted stages of growth. For Forage 1, the stages of growth of brome grass during Trials 1

and 2 were full bloom and seed, respectively. The stages of growth of the alfalfa in Forage 2 were characterized as early bloom and post bloom, respectively, during Trials 1 and 2. Also, the aftermath of both forages was examined in Trial 3 at a stage designated as vegetative for brome grass (Forage 1) and as early bloom for alfalfa (Forage 2).

The feeding and grazing procedures were similar to those described for the 1949 and 1950 trials. Total collections of feces were made during periods of 4 to 11 days and, in the hand-feeding trials, were preceded by preliminary feeding periods of 8 to 26 days. The initial weights of the Holstein steers used in the 1951 trials ranged from 320 to 950 lb. All groups consisted of three steers each except during Trials 1 and 2 with Forage 2 when two steers composed the grazing group.

Other than the kinds of pasture used, the major difference between the trials conducted in 1951 and those in 1949 and 1950 was the amount of herbage made available to the grazing steers. During 1949 and 1950, relatively small areas were allotted to the grazing animals. During 1951, the size of paddocks grazed was much greater. Areas of approximately 3,000 sq. yd. were grazed during Trials 1, 2 and 3 with Forage 1 and during Trials 1 and 2 with Forage 2. In an attempt to afford a maximum opportunity for the selective grazing of Forage 2 during Trial 3, the three steers were provided an area of approximately 6,000 sq. yd.

Criteria of selective grazing. For the purposes of this investigation, "selective grazing" is defined as that in which animals select a diet of a chemical composition different from that of the whole, clipped herbage.

The criteria of the degree to which discriminate grazing occurred during these trials were differences in: *(a)* the amounts of proximate constituents in the feces of grazing animals and of animals fed the respective whole, clipped herbages, *(b)* the digestibility of the dry matter consumed by grazing steers and steers hand-fed herbage clipped from the same pasture, and *(c)* the estimated composition and digestibility of the proximate constituents of grazed herbage and the measured composition and digestibility of the nutrients of the whole, clipped herbage.

RESULTS AND DISCUSSION

Composition of feces. Consistent differences were found in the chemical composition of the feces of grazing and hand-fed steers. In almost all cases, the amounts of crude protein, ether extract, and ash were higher and that of crude fiber was lower in the feces of grazing animals than in those of animals hand-fed from the same source of herbage. An analysis of variance revealed that these differences were highly significant.

Differences in fecal composition in themselves, however, do not demonstrate that grazing steers consume a diet of a composition different from that represented by whole, clipped herbage. If, as a preliminary consideration, it is assumed that the grazed herbage contained approximately the same percentage of crude protein, ether extract, and fiber as the whole herbage, these observations

could mean that the herbage selected by the grazing steers contained crude protein and ether extract which were less digestible and crude fiber which was more digestible than that of the whole plant. However, the digestibility of the dry matter consumed by the grazing steers was found to be significantly greater than that of the clipped herbage. Since it is untenable that animals yielding feces so composed may have selected forage of which the dry matter was more digestible, yet of the same chemical composition as that of whole herbage, it was concluded that the grazed diet contained a higher level of crude protein, ether extract, and mineral matter and a lower concentration of crude fiber than the whole plant.

As a result of these observations an estimate was made of the composition of the herbage and the digestibility of the proximate constituents consumed by the grazing steers.

Estimation of proximate composition of grazed herbage. Since the chemical composition of the herbage actually consumed by grazing animals cannot be determined directly with certainty, the composition of the grazed herbage was derived indirectly. For this purpose, the percentage indigestibility of the nutrients of the whole herbage, the composition of whole herbage, and the composition of the feces of the hand-fed steers served as reference bases. Since the intake and outgo of dry matter and the chemical composition of the feces of the grazing animals were known, it was possible to effect a relatively accurate estimate of the composition of the consumed forage and of the digestibility of the individual nutrients.

The first step in the procedure employed was to determine the difference in the quantities of protein, crude fiber, ether extract, nitrogen-free extract and ash voided in the feces of the grazing and hand-fed animals when the amount of dry matter excreted by the grazing steers was corrected to the same amount voided by their mates which consumed the whole plant. Since the digestibility of the dry matter in the whole forage was different from that of the grazed forage, the quantity of nutrients voided in the feces of the grazing animals was corrected in accordance with the difference in the indigestibility of the dry matter. It is recognized that the correction for indigestibility in this manner results in a uniform correction of the digestibility of that proportion of each nutrient which was selected in greater or lesser amount than that consumed by hand-fed animals. Although distributing uniformly the difference in the total digestibility of the two forms of herbage (i.e., whole and grazed) among all nutrients may not be strictly accurate, certain relationships concerning the plant parts consumed and the chemical composition and digestibility of the plant parts indicate that this scheme is not subject to a great error.

The corrected differences in the amounts of the various constituents in feces resulting from the grazed and hand-fed herbages were divided by the indigestibility coefficients of the nutrients of the clipped herbage. This computation gave an estimate of the difference between the content of each nutrient in the herbage consumed by grazing steers and that of each nutrient consumed by the hand-fed steers. These quantities then were added to, or deducted from, the quantities of

TABLE 1

Composition and digestibility of herbage selected by grazing steers as compared with that of whole herbage cut from the same source

Trial No.	Steer No.	Composition of herbage dry matter (%)					Digestibility (%)					
		Crude protein	Ether extract	Crude fiber	N.F.E.	Ash	Dry matter	Crude protein	Ether extract	Crude fiber	N.F.E.	Ash
1949—Forage 1												
1	0	19.5	6.4	21.6	45.5	7.0	78	79	62	78	81	66
	36	17.4	5.2	23.0	46.7	7.7	77	77	60	77	80	64
	39	17.0	5.4	23.9	46.6	7.1	76	77	60	77	80	63
Whole herbage		16.1	4.8	25.2	46.4	7.5	73	74	54	73	77	58
2	0	14.2	5.5	24.0	47.6	8.7	72	72	64	71	75	66
	36	13.9	5.0	25.8	47.2	8.1	67	67	58	66	70	61
	39	12.8	4.8	26.5	48.5	7.4	69	69	66	67	72	62
Whole herbage		12.0	4.3	27.3	49.5	6.9	66	66	56	65	69	59
3	0	12.4	4.3	27.6	48.6	7.1	59	62	32	60	61	47
	39	10.6	3.2	31.1	50.0	5.1	58	60	29	59	60	45
Whole herbage		10.4	3.3	31.8	49.1	5.4	58	61	30	59	60	45
1950—Forage 1												
1	4	22.9	5.0	26.5	39.1	6.5	75	79	47	76	76	66
	5	25.0	6.2	25.0	36.9	6.9	75	80	48	77	77	67
	6	24.7	6.8	27.7	33.4	7.4	76	81	50	78	79	69
Whole herbage		20.2	4.7	27.9	39.4	7.8	73	78	42	74	74	64
2	4	14.6	4.3	31.5	42.2	7.4	66	71	54	68	66	56
	5	14.5	4.6	31.7	42.4	6.8	65	70	51	67	65	54
	6	14.6	4.0	34.5	39.8	7.1	64	69	50	67	64	53
Whole herbage		13.7	4.1	33.7	41.7	6.8	66	71	54	68	66	56
3	4	10.9	3.0	31.2	48.7	6.2	57	57	40	51	64	38
	5	12.9	3.2	26.5	50.7	6.7	60	61	29	55	67	44
	6	11.7	3.0	26.7	52.2	6.4	57	58	32	52	64	39
Whole herbage		9.1	2.9	32.9	50.0	5.1	54	55	40	48	61	35
4	4	6.9	2.0	36.6	49.5	5.0	54	35	24	57	58	29
	5	7.4	3.4	35.1	48.6	5.5	57	41	30	61	61	35
	6	6.8	2.4	37.0	48.4	5.4	54	36	25	58	58	30
Whole herbage		6.8	1.9	37.2	48.9	5.2	55	36	25	58	59	30
1950—Forage 2												
1	10	26.0	2.9	24.3	40.8	5.0	72	80	37	70	76	34
	11	23.4	3.4	25.5	43.4	4.3	70	78	31	67	75	24
	12	24.7	4.4	22.9	43.0	5.0	75	82	42	72	79	40
Whole herbage		22.0	3.8	26.7	39.9	7.6	72	80	37	70	77	44
2	10	21.8	5.4	25.8	38.8	8.2	67	77	58	59	70	53
	11	20.8	3.5	28.6	40.2	6.9	61	73	51	52	66	46
	12	23.5	5.0	27.5	35.1	8.9	68	78	59	60	71	55
Whole herbage		16.5	3.1	31.8	41.3	7.3	59	72	50	50	64	44
3	10	11.7	3.8	31.8	45.7	7.0	59	62	54	59	63	31
	11	11.7	3.2	35.1	45.1	4.9	56	63	50	54	59	24
	12	12.7	4.3	31.7	45.0	6.3	58	64	54	57	61	27
Whole herbage		9.7	2.3	37.0	45.4	5.6	53	61	47	52	58	20
4	10	19.9	3.2	24.5	45.3	10.1	66	75	32	65	71	44
	11	17.3	2.0	25.8	40.7	14.2	61	71	23	60	67	37
	12	18.0	2.4	26.9	41.0	11.7	62	71	24	60	68	38
Whole herbage		18.2	3.4	29.9	40.4	8.1	64	73	26	61	69	40
5	10	24.7	4.9	21.3	40.9	8.2	68	80	39	58	75	45
	11	23.6	4.5	22.1	42.3	7.5	66	79	35	55	73	41
	12	25.0	5.4	21.6	39.7	8.3	69	80	41	59	75	46
Whole herbage		19.9	3.2	30.5	39.3	7.1	62	76	29	50	70	35

TABLE 1 (continued)

Composition and digestibility of herbage selected by grazing steers as compared with that of whole herbage cut from the same source

Trial No.	Steer No.	Composition of herbage dry matter (%)					Digestibility (%)					
		Crude protein	Ether extract	Crude fiber	N.F.E.	Ash	Dry matter	Crude protein	Ether extract	Crude fiber	N.F.E.	Ash
1950—Forage 3												
1	16	22.7	3.9	29.8	33.9	9.7	70	77	36	73	70	55
	17	21.9	3.6	28.4	37.4	8.7	70	77	36	73	70	55
	18	22.1	4.7	29.4	34.0	9.8	71	78	39	74	72	58
Whole herbage		20.6	4.1	30.1	36.6	8.6	72	78	40	75	72	58
2	16	16.0	4.1	29.7	39.8	10.4	67	73	61	65	68	59
	17	15.3	3.8	30.5	40.1	10.3	62	69	56	60	64	54
	18	16.1	4.7	28.5	40.1	10.6	65	71	59	63	67	57
Whole herbage		13.0	3.1	34.2	42.3	7.4	63	70	57	61	65	55
3	16	14.1	4.3	29.3	44.3	8.0	59	69	50	51	64	43
	17	14.1	3.9	27.5	47.2	7.3	59	69	49	50	64	43
	18	15.2	5.5	28.8	43.0	7.5	59	70	50	51	64	44
Whole herbage		10.4	2.4	33.3	47.0	6.9	54	66	44	45	60	37
4	16	26.5	3.5	22.7	36.0	11.3	67	79	27	61	71	49
	17	27.6	4.3	22.1	35.8	10.2	68	80	31	63	72	52
	18	28.6	4.8	20.7	35.7	10.2	68	79	29	62	72	50
Whole herbage		20.1	2.6	31.9	37.7	7.7	60	75	13	53	66	39
5	16	23.8	4.3	23.3	39.6	9.0	68	79	27	59	75	47
	17	23.2	4.5	22.7	41.4	8.2	67	78	25	58	75	46
	18	24.0	4.6	22.3	39.7	9.4	67	78	25	58	75	46
Whole herbage		19.1	2.6	29.9	41.6	6.8	60	73	8	49	69	34
1951—Forage 1												
1	23	10.7	4.7	36.5	42.3	5.8	67	63	62	69	66	61
	24	10.7	4.4	35.4	44.1	5.4	65	62	60	68	65	60
	25	10.8	5.8	31.1	46.6	5.7	69	68	67	68	71	67
Whole herbage		8.3	3.1	39.1	44.3	5.2	62	58	57	65	62	56
2	23	8.2	2.7	31.2	50.8	7.1	55	46	48	57	60	28
	24	9.0	2.4	33.5	48.0	7.1	55	46	48	57	60	28
	25	8.7	2.4	33.0	47.7	8.2	56	47	49	57	61	29
Whole herbage		7.1	2.2	38.0	47.7	5.0	53	42	44	54	58	22
3	23	18.6	1.6	26.8	39.1	13.9	60	70	−7	62	62	44
	24	16.7	1.6	25.8	41.5	14.4	59	70	−8	61	62	44
	25	16.5	1.8	26.8	41.8	13.1	62	72	−1	64	64	47
Whole herbage		15.8	1.8	30.1	43.4	8.9	61	71	−6	62	63	45
1951—Forage 2												
1	29	26.1	7.0	18.2	34.8	13.9	68	78	62	56	69	64
	30	23.1	6.2	23.9	34.2	12.6	65	78	61	52	68	63
Whole herbage		17.0	3.1	32.7	38.5	8.7	57	73	54	45	63	58
2	29	31.0	7.1	18.8	28.6	14.5	68	82	65	52	68	64
	30	27.4	6.3	23.4	30.6	12.3	64	79	61	46	65	60
Whole herbage		19.2	2.3	34.9	35.5	8.1	56	77	56	39	60	55
3	29	27.7	3.7	15.3	37.5	15.8	73	81	30	57	81	62
	30	24.2	3.5	16.6	41.7	14.0	71	80	26	55	80	60
	31	24.0	2.9	18.6	40.5	14.0	68	78	18	50	78	56
Whole herbage		19.4	2.2	27.3	41.2	9.9	68	79	21	52	79	57
Means for all herbages												
Grazed herbage		18.1	4.3	26.6	42.1	8.9	66	70	43	62	69	51
Whole herbage		14.7	3.1	31.9	43.2	7.1	62	68	39	58	66	47

the respective nutrients consumed in clipped herbage (to result in the proportions of the various nutrients which must have been consumed by grazing animals in order to have yielded feces so composed). Upon expressing these proportions as percentages, the composition of the consumed forage was obtained.

The digestibility of the individual nutrients was readily computed from the estimated composition of the grazed herbage, the composition of the feces of grazing animals, the amount of dry matter consumed in the forage, and the amount of dry matter excreted in the feces by grazing steers.

Nature of selected herbage. A comparison of the composition of herbage selected by grazing steers with that of the whole, clipped herbage of six different pastures during various stages of plant growth is shown in Table 1.

In an examination of all data obtained in the 66 steer-grazing trials, it was found that the average diet selected by grazing animals contained 23.3% more of crude protein, 37.3% more of fat, and 25.6% more of ash and 16.8% less of crude fiber than the whole herbage.

The size of area grazed and, in general, the amount of herbage available for grazing were greater in 1951 than in 1949 and 1950. In a few of the trials conducted in 1950, some of the smaller areas contained more herbage than some of the larger ones. Consequently, the opportunity for selection during this year was not restricted in all trials as much as was desired. Although a greater degree of selection was evident in the grazing of large areas of alfalfa in 1951 than in the grazing of small areas of the herbages studied in 1949 and 1950, the influence of the amount of herbage available is confounded to some extent with that of the botanical composition of the herbage, season, and stage of growth. Brome grass was studied approximately one week earlier than alfalfa in each of the three trials conducted during 1951, but it was not grazed as selectively as the alfalfa. The alfalfa was more abundant and of an earlier growth stage than brome grass.

Although the stage of growth, botanical composition, and other characteristics of the sward may have had a modifying effect, these data indicate that the degree of selection by grazing steers is influenced by the amount of forage available.

In Table 1, a comparison is made of the digestibility of the proximate constituents of the grazed and hand-fed herbages. These data show that all nutrients of the herbage selected by the grazing steers were consistently more digestible than those of the whole herbage hand-fed to similar animals. Even though restricted grazing was practiced in most of these trials, the dry matter of grazed herbage was approximately 6% more digestible than that of the whole herbage from the same source. In the usual grazing practice it is expected that the difference in the digestibility of whole and selected herbage would be considerably greater and possibly would approach that found with alfalfa (Forage 2, 1951) in this study (10 to 25%).

Seasonal variations in the composition and digestibility of whole and grazed herbages. The data in Table 1 show that the content of crude protein and ether extract decreased and that of crude fiber increased in both whole and grazed

herbage as growth proceeded uninterruptedly. The digestibility of both kinds of forage also declined as herbage growth approached maturity.

The aftermath growth of certain of the pastures was found to contain a high level of crude protein and a low level of crude fiber and, in general, was similar in composition to immature first-growth herbage. Despite the favorable composition of hand-fed or grazed aftermath herbage, it was less digestible than the early-spring, first-growth herbage of the same pastures.

Individuality of grazing animals. The diet consumed by steers grazing the same herbage varied considerably in composition. In the 1949 and 1950 trials, the restricted grazing conditions imposed possibly precluded the manifestation of the maximum preferences of the animals. However, it was observed that the degree of discrimination exercised by a given animal, relative to that by his mates, was consistent throughout the season (Table 1).

In addition to the differences in composition of herbage consumed by a group of steers grazing the same herbage, the digestibility of the nutrients also varied. Generally, the digestibility was greater for all nutrients of grazed herbage which contained more of crude protein, ether extract, and mineral matter and less of crude fiber than for those of grazed herbage containing smaller quantities of crude protein, ether extract, and ash and more of crude fiber.

The data obtained with Steer 31, Forage 2, Trial 3, 1951, are of special interest. This animal was about one year older and considerably larger than his mates (Steers 29 and 30). During the previous year (1950) Steer 31 had been used in a different kind of experiment in which it was observed that he was affected with a digestive disorder. In the present experiment (1951), Steer 31 again yielded feces of a watery nature and of foul odor, suggesting that he was affected with a chronic digestive disturbance. It is interesting to note that although Steer 31 selected herbage of a composition similar to that consumed by Steer 30, the nutrients consumed, particularly crude fiber and ether extract, were not digested nearly as well as they were by Steer 30. It is noteworthy also that Steer 31 did not digest nutrients as well as steers fed the whole plant, though he consumed a diet of more favorable composition.

The fact that only small variations in digestibility existed among animals hand-fed a given clipped herbage suggests that the much greater variation in digestibility observed among animals grazing the same herbage is the result of differences in individual preferences.

Although the data obtained in this investigation demonstrate that grazing animals select herbage which is more digestible, of a higher content of crude protein, crude fat, and mineral matter and of a lower crude fiber content than the whole herbage available for grazing, they do not provide information on what factors cause animals to graze discriminately. It is practically impossible to isolate the animal's preference for herbage of a given composition from that for herbage of various physical characteristics and degrees of palatability, since these characteristics appear to be closely interrelated. Herbage high in leaves and low in stems contains more of crude protein, ether extract and mineral matter and less of crude fiber than that low in leaves and high in stems. Since

the leaves generally are more palatable (possibly because of physical qualities) and more accessible than the stems, it seems likely that animals consume herbage of a given chemical composition for reasons other than a desire or need for certain chemical constituents.

A study made to determine the influence of discriminate grazing upon herbage intake revealed no correlation between dry matter intake per unit of body weight and the extent to which either crude protein or crude fiber was selected. Since the animals employed in these studies were small and growing, it is possible that different results may be obtained with milking cows, for which the nutrient requirements are much greater.

Significance of selective grazing in the evaluation of pastures. Workers in several countries have given much effort to the development of methods for the measurement of digestibility and intake of herbage under conditions of grazing. A recent review of these experiments suggests that selective grazing is the main difficulty encountered *(12)*. Although the use of indicator methods for measuring digestibility and intake shows much promise, it is essential that the method employed allow circumvention of the error caused by selective grazing. Of the methods available at the present time, that employing the concentration of plant pigments (oxidized porphyrins) in the feces *(13)* as the indicator appears to be the most satisfactory. At the present time, the success of other indicator methods depends upon the degree of similarity between the chemical composition of the grazed herbage and that of herbage obtained manually for analysis. The results of the present investigation demonstrate that the chemical composition of clipped herbage is a very unreliable index of the composition of grazed herbage. Furthermore, the analysis for an indicator in clipped herbage would result in digestibility estimates and, thereby, intake estimates with errors of a corresponding magnitude. It is probable that plucked herbage samples are more nearly like grazed herbage than whole, clipped herbage. However, the use of plucked herbage for an indicator analysis also results in digestibility estimates of uncertain accuracy.

In a recent report, Cook and Harris *(1)* concluded that the chromogen indicator procedure is not satisfactory for the measurement of digestibility of range shrubs and browse. However, these workers did not employ the chromogen method as adapted for grazing experiments *(13)* but, rather, attempted to employ a ratio technique requiring the measurement of the chromogen in plucked forage samples (which probably did not represent the grazed forages) as well as that in the feces of the grazing animals. In addition, the use of dried samples of feces and forage *(1)* may have contributed to erroneous conclusions. The objective of that experiment was to compare the chromogen technique with the lignin-ratio method for effecting digestibility measurements under grazing conditions. It is noteworthy that neither of these methods was sufficiently well established, particularly in work with range browse, to serve as a standard for the other. The degree of agreement between the results of the conventional digestion trial and that of an indicator method is by necessity the only test of accuracy of an indicator method. The conclusions drawn by Cook and Harris *(1)* that the chromogen procedure is not satisfactory for use with range plants and that, of the two

indicator methods, the lignin-ratio appeared more feasible may be correct. However, since these workers did not conduct conventional trials, they failed to determine the adequacy of either indicator method. The fact that the coefficient of variation for the chromogen content of the feces was greater than that for the lignin content of the feces appears to have influenced the conclusions drawn by these workers. This observation may actually mean that the sensitivity of the chromogen procedure is greater than that of the lignin-ratio method for the detection of an individual animal's preference. In the experiments reported here, it was found that the variation in the digestibility of herbage grazed from the same source may be very great.

Since analyses were made of plucked forage samples and since the chromogen method as adapted for grazing studies *(13)* was not employed in the experiments of Cook and Harris *(1)*, digestion coefficients have been computed from the chromogen concentration of the feces reported by these workers. In computing these data, it is recognized that the "chromogen unit" employed by Cook and Harris may not be exactly the same as that employed in our laboratory, but the value given for alfalfa hay (which was fed in a conventional digestion trial) suggests that the "chromogen units" used in both laboratories have approximately equivalent values. The dry matter digestion coefficients for the various range plants computed from the use of the fecal chromogen level are: big sagebrush, 48.1; shadscale, 51.5; winterfat, 50.6; black sage, 51.6; and squirrel-tail grass, 46.9. The digestibility of the alfalfa hay computed in the same manner was 60.8%. Although the chromogen procedure may not be used satisfactorily for all range plants, the values obtained here for big sagebrush and winterfat agree well with the values (51.8 and 52.0% TDN on dry basis, respectively) obtained in conventional digestion trials reported by Morrison *(9)*. Digestion coefficients for the other range plants in this group are not recorded in Morrison's tables. Consequently, it would appear that the manual forage sampling-selective feeding error was, at least partly, responsible for the negative digestion coefficients obtained by Cook and Harris *(1)* for certain shrubs and may have effected errors in the other digestion coefficients reported.

SUMMARY

An investigation was made of the degree of selective grazing exercised by growing steers. A series of 66 individual trials was conducted with six herbages, each at three to five different stages of growth.

The degree of discriminate grazing was marked with almost all herbages examined. The diet selected by grazing steers was higher in crude protein, ether extract, and mineral matter and lower in crude fiber than the whole herbage available for consumption. All proximate constituents of grazed herbage were more digestible than those of clipped herbage from the same source fed to stall-confined steers. The extent to which animals selected was not related to the intake of dry matter.

Digestibility of dry matter and the amounts of crude protein and ether extract

decreased, and the amount of crude fiber increased, as first-growth herbage became more mature. Although aftermath herbage contained a high level of crude protein and a low level of crude fiber, it was somewhat less digestible than first-growth forage of comparable composition.

The restriction of grazing to small areas containing small quantities of herbage tended to reduce the extent of selection, whereas providing large quantities of herbage increased the degree of selection. Certain characteristics of herbage, such as the kinds of plants present, stage of growth, proportions of leaves and stems, and accessibility of plant parts, may have influenced to some extent the results obtained. Preference of animals for herbage possessing certain physical qualities, or qualities affecting palatability, may have resulted in the consumption of a diet differing chemically from the whole herbage.

The consistency with which animals grazed discriminately under a variety of herbage conditions suggests that certain qualities inherent in the animal may influence the degree of selection practiced.

The results of this investigation demonstrate that the chemical composition of clipped herbage is an unreliable index of the chemical composition of herbage selected by grazing animals. Also, the digestibility of clipped herbage is of uncertain value and may be quite misleading in regard to estimating the value of pasture under grazing conditions.

REFERENCES

(1) Cook, C. W., and Harris, L. E. A Comparison of the Lignin Ratio Technique and the Chromogen Method of Determining Digestibility and Forage Consumption of Desert Range Plants by Sheep. *J. Animal Sci.*, **10**: 565. 1951.

(2) Davies, W. The Relative Palatability of Pasture Plants. *J. Ministry Agr.*, **32**: 106. 1925.

(3) Hancock, J. Grazing Habits of Dairy Cows in New Zealand. *Empire J. Exptl. Agr.*, **18**: 249. 1950.

(4) Hesselgren, N. L. Pan Svecus. *Amoenitates Academicae*, **2**: 225. 1749.

(5) Hobbs, C. S., Gallup, W. D., and Taylor, B. R. The Composition and Apparent Digestibility of Bluestem Grass in the Growing Stage, and in the Dry and Hay Stages when Supplemented with Cottonseed Cake. *J. Animal Sci.*, **4**: 395. 1945.

(6) Johnstone-Wallace, D. B. The Influence of Grazing Management and Plant Associations on the Chemical Composition of Pasture Plants. *J. Am. Soc. Agron.*, **29**: 441. 1937.

(7) Johnstone-Wallace, D. B., and Kennedy, K. Grazing Management Practices and their Relationship to the Behavior and Grazing Habits of Cattle. *J. Agr. Sci.*, **34**: 190. 1944.

(8) Jones, M. G. Grassland Management and Its Influence on the Sward. IV. The Management of Poor Pastures. V. Edaphic and Biotic Influences on Pasture. *Empire J. Exptl. Agr.*, **1**: 361. 1933.

(9) Morrison, F. B. *Feeds and Feeding*, 21st ed. 1951. Morrison Publ. Co., Ithaca, N. Y.

(10) Orr, J. B. *Minerals in Pastures.* Lewis and Co., London. pp. 14-15. 1929.

(11) Osvald, H. Smokligheten hos Olika Gräs. *Svenska Mossk Fören Tidskr.*, **46**: 154. 1932.

(12) Reid, J. T. Indicator Methods, their Potentialities and Limitations. *Proc. Sixth Intern. Grasslands Congr.*, pp. 1334-1339. 1952.

(13) Reid, J. T., Woolfolk, P. G., Hardison, W. A., Martin, C. M., Brundage, A. L., and Kaufmann, R. W. A Procedure for Measuring the Digestibility of Pasture Forage under Grazing Conditions. *J. Nutrition*, **46**: 255. 1952.

(14) SALTONSTALL, L. The Measurement of the Quantity and Quality of the Pasture Herbage Consumed by Sheep. A Technique Study. Ph.D. Degree Thesis, Cornell Univ. 1948.
(15) STAPLEDON, R. G. Palatability and Management of the Poorer Grass Lands. *J. Ministry Agr.*, **41**: 321. 1934.
(16) STAPLEDON, R. G. Pastures Old and New. The Animal's Point of View. *J. Ministry Agr.*, **55**: 231. 1948.
(17) TIEMANN, A., AND MÜLLER, G. Beobachtungen über die Schmackhaftigkeit verschiedener, Gräser und Kleearten bei freiem Weidegang. *Tierernähr. Tierzucht*, **9**: 252. 1933.
(18) TRIBE, D. E. The Importance of the Sense of Smell to the Grazing Sheep. *J. Agr. Sci.*, **39**: 309. 1949.
(19) TRIBE, D. E. The Composition of a Sheep's Natural Diet. *J. Brit. Grassland Soc.*, **5**: 81. 1950.
(20) TRIBE, D. E., AND GORDON, J. G. The Importance of Color Vision to the Grazing Sheep. *J. Agr. Sci.*, **39**: 313. 1949.
(21) WOODMAN, H. E., AND EVANS, R. E. Nutritive Value of Pasture. VI. The Utilization by Sheep of Mineral-Deficient Pasture. *J. Agr. Sci.*, **20**: 587. 1930.
(22) WOOLFOLK, P. G. Development and Evaluation of the Chromogen(s) Method for Determining Digestibility and Consumption of Feeds by Ruminants. Ph.D. Degree Thesis, Cornell Univ. 1950.

Information for Authors

The Journal of Dairy Science is devoted for the most part to the publication of articles reporting original research by the members of the Association. In joint authorship, only one author of a scientific article need be a member. Occasionally, papers of significant and outstanding merit will be accepted from nonmembers. Reviews of literature and other special articles are prepared by invitation of the Editor. Articles that already have appeared in print or that are intended for simultaneous publication elsewhere will not be accepted.

Manuscripts reporting the results of original research will be published as nearly as possible in the order of their receipt. Exact order of publication depends on the amount of time required for review by the editorial board and the necessary revisions.

P. H. TRACY, *Editor*

PREPARATION OF THE MANUSCRIPT

1. Organization

In general, articles should be prepared according to well-established procedure for scientific experimental work, as follows:

a. Introductory statements, giving the general problem, the prior investigations, and the purpose of the present study.
b. Explanation of the methods used.
c. Results and discussion.
d. Summary.
e. Acknowledgments.
f. References cited.

2. Style

General: Articles should be written in concise, clear style and should be no longer than necessary to give pertinent facts as to the purpose of the study, the methods used, and the conclusions reached. Nonreview articles should be limited to 12 printed pages. A charge of $18 for each over page will be made. Unnecessary detailed descriptions of tabular matter in the text should be avoided, as well as duplication in graphs of data appearing in tables.

Authors' names: Men's names are given with initials, unless otherwise requested, and titles are not used except for military personnel. The department and the university (or the commercial organization) and the address follow the names of the authors.

Mechanical: Manuscripts must be typed, double spaced, on standard letter size bond paper, leaving one-inch margins. The original copy must be submitted. Illustrative material should accompany the manuscript and should not be larger than the typewritten pages. Footnote references from the text are numbered with superior Arabic numerals consecutively throughout the manuscript. Footnotes may be written on the bottom of the pages on which the references occur, separated from the text by a line typed across the page.

The use of many subdivisions and subtitles in the manuscript is to be avoided. When desirable to enumerate a list within a paragraph, the items should be indicated by lower-case letters in parentheses.

3. Abbreviations

Units of measurement (except periods of time) are abbreviated when preceded by a numeral, not otherwise: 50 ml., per milliliter, 6 months. The following abbreviations and symbols are used:

A.	Angstrom unit(s)
amp.	ampere(s)
atm.	atmosphere(s)
av.	average
b.p.	boiling point
B.O.D.	biochemical oxygen demand
B.t.u.	British thermal unit(s)
cc.	cubic centimeter
C.	Centigrade
cm.	centimeter(s)
cu.m.	cubic meter(s)
cwt.	hundredweight
d.	density (for formula and table use only)
DDT	(without periods)
e.m.f.	electromotive force
η	viscosity (for formula and table use only)
F.	Fahrenheit
FCM	fat corrected milk
f.p.	freezing point
ft.	foot (feet)
g.	gram(s)
γ	microgram(s)

h.p.	horsepower
kcal.	kilocalorie(s)
kg.	kilogram(s)
kw.	kilowatt(s)
l.	liter(s)
lb.	pound(s)
log	logarithm
m.	meter(s)
M	thousand
M	mole, molar
max.	maximum
mc.	millicurie(s)
mg.	milligram(s)
min.	minimum
ml.	milliliter(s)
m*M*	millimole(s)
mm.	millimeter (s)
mμ	millimicron(s)
mol. wt.	molecular weight
μ	micron(s)
μc.	microcurie(s)
mv.	millivolt(s)
N	normal (as applied to concentration)
n	index of refraction (formula and table use only)
NE	net energy
No.	number(s)
oz.	ounce(s)
p.p.m.	parts per million
%	per cent
p.s.i.	pounds per square inch
qt.	quart
quart.	quarterly
r.p.m.	revolutions per minute
sp. gr.	specific gravity
sp. heat	specific heat
sp. vol.	specific volume
sq. cm.	square centimeter (cm.^{2} in formulas)
TDN	total digestible nutrients
U.S.P.	United States Pharmacopeia
v.	volt(s)
viz.	namely
vs.	versus
w.	watt(s)
yd.	yard(s)

4. Numerals

Arabic numerals of ten and below are written out except when preceding units of measurement: seven cows, 6 lb. Numbers above ten are written as figures except at the beginning of a sentence. However, similar numbers in a series are treated alike: The animals consisted of 4 Holsteins, 11 Ayrshires, and 15 Brown Swiss. Usually, a number occurring as an isolated instance is written out.

5. Italics

Italics are indicated by underlining. Scientific names of genera and species are italicized, using the terminology approved by the society representing that branch of science.

Most foreign phrases which are in common usage are not italicized: in vacuo, in vitro, ad libitum, i.e., viz. The phrase *et al.* is italicized.

Italics should not be used for emphasis.

6. Capitalization

The name of a class, order, or genus is capitalized; the name of a species is not: *Streptococcus lactis*. Trade names and market grades are capitalized: Pyrex, U. S. Standard. A descriptive term denoting a definite region is capitalized, but mere direction is not: the Middle West, southern California. The words "department," "bureau," and "division" are capitalized when they represent an official organization: Bureau of Dairy Industry, Department of Animal Science. "Government" and "federal" are not capitalized in such expressions as: government agents, federal courts. Names of important events are capitalized: World War II, but, the last war. In a list preceded by a colon the first word of each complete statement is capitalized. A noun preceding a numeral used to designate sequence should be capitalized: Experiment III, Figure 2.

7. Hyphens

In the Journal the following uses of the hyphen are encountered most frequently:

A hyphen is used to form an adjectival expression (with the exception of chemical terms): 1-ml. pipette, 10-year period; in spelled out fractional numbers: two-thirds; and in compound numerals: twenty-three, eighty-first. Ordinarily, prefixes joined to roots do not retain the hyphen except before proper names: nonfat, nonreturn, biweekly, pretreatment. In parts of titles "vice" and "ex" require a hyphen: Vice-President. A hyphen is necessary to avoid a diphthong: co-author, intra-uterine.

8. Tables

Tables are expensive to put into print and should not be used when the data can be expressed clearly in the text. Table titles should be brief, yet explanatory, and excessively large tables should be avoided. Only the first word is capitalized. If possible, subheadings should refer to vertical columns. They are numbered with Arabic numerals, and footnotes are numbered a, b, c, etc. for each table. Vertical lines are not used in tables, since to do so would add considerably to the cost. Tables should be on separate sheets from the text.

In reporting temperatures, use either Centigrade or Fahrenheit consistently and use the scale used in the actual test in order to avoid reporting values such as 80.6° F. when the thermometer used was Centigrade and the temperature was approximately 27° C.

Values reported in round numbers represent approximations, such as 1 lb., 4 ft., and 37° C.; values accurately determined should be expressed as 1.0 lb., 4.0 ft., and 37.0° C.

When it is desired to indicate in a table that information for some reason is not available use "....." A zero (0) in the table indicates that the value was obtained experimentally. All decimals less than unity should be preceded by a zero: 0.56. This holds for both the text and tabular material, and for statistical data.

9. Figures

All figures, diagrams, photographs, and drawings should be given an Arabic number and are referred to as figures. They should be used only as necessary to explain the text without duplicating data given in tables. Original drawings are best done in India ink on tracing cloth or heavy white paper not larger than standard letter size. Lettering should be in block style and of such size that it will be not less than 1/16 inch in height when the figure is reduced to 4 inches maximum dimension. Glossy print photographs are necessary for halftone reproductions. Legends for figures should be typed separately from the illustrations. Microphotographs should have the magnification indicated as it will appear in the Journal. (This will be inserted by the author at the time of reading proof.) When configurational structures of chemical compounds are used, drawings suitable for reproduction by photo-engraving are to be furnished by the author.

10. Statistical analysis of data

Whenever practicable, the experiments reported should be designed so that their results can be analyzed statistically as follows:

a. Papers dealing with absolute values of such items as the physical constants and chemical composition of milk or other dairy products should express them as the mean of a given number of observations with the variability reported in terms of their standard deviation or some other acceptable precision index.

b. When a new analytical procedure is proposed or statements are made concerning the accuracy of a test, information should be supplied as to its precision, expressed in terms of an acceptable index with the number of degrees of freedom employed in its evaluation, its completeness of recovery expressed in such a manner that the significance of the results may be noted by acceptable statistical procedures.

c. When the paper deals with the relative effect of an independent variable upon dependent variables, the significance of the change produced should be established by an analysis of variance.

12. References

Literature references in the text are cited by Arabic numerals in parentheses. The term *"et al."* is used in the text when there are more than three authors. The citations appear at the end of the paper, listed alphabetically according to authors, numbered consecutively, and double spaced. The authors of the manuscript are responsible for the accuracy and completeness of the references. Each reference should contain the reference number, author(s), title of article, name of journal, volume, number (when each issue is paged separately), first page, and year of publication. Publications are abbreviated according to the form given in CHEMICAL ABSTRACTS, Vol. 45, No. 24, Part 2, 1951. Names of books and of periodicals will be set in italic type.

PROOFREADING

After an article is set in type, the author designated to do so receives the galley proof and the manuscript so that he may verify particularly the tables, proper names, and scientific terms and make any needed corrections. Revisions not absolutely necessary should be avoided, and less expense is involved if any changes made in the text are compensated, i.e., if the number of letters and spaces taken out equals those given in the new text. Where revisions are made in the galley proof, the authors will be asked to bear the additional expense. Conventional proofreaders' marks should be used. The corrected galley proof is to be signed by the author and returned with the manuscript to the EDITOR as soon as possible. The editor will make a final check and send the corrected proof to the printers.

REPRINTS AND BIOLOGICAL ABSTRACTS

The galley proof sent to the author is accompanied by instructions regarding orders for reprints, giving prices, and an order form to be returned to the PRINTER. Reprints should be ordered in advance of publication, since they are made soon after an article is published. The editorial office has nothing to do with ordering reprints.

The galley proof sent to the author is accompanied also by a blank form for an abstract to be published in Biological Abstracts. Authors are to prepare this statement and return it to the PRINTER. As a rough estimate, the abstract should contain about twenty words for each thousand words of an article.

EDITING AT THE DEPARTMENTAL LEVEL

It is recommended that all departments establish an editorial board to review manuscripts before they are submitted to the Journal for publication. It has been observed that the best papers generally are those submitted by the departments that follow this practice. It is also recommended that all persons typing manuscripts for the Journal be given an opportunity to study the Journal's regulations regarding the preparation of the manuscript as set forth in these pages. A limited number of reprints will be available so that a copy can be kept on permanent file in each departmental office.

PEOPLE and EVENTS
in the Dairy Science World

Pioneers in the Dairy Industry

At any important meeting of dairy scientists, whether that meeting be held here or abroad, OTTO FREDERICK HUNZIKER is likely to be one of those present. Listed in 1930 as one of "the ten master minds of dairying," Dr. Hunziker for many years has played an important part in the advancement of dairy science. His books *The Butter Industry* and *Condensed Milk and Milk Powder*, several times revised, have been the source of authoritative information for colleges, as well as industry, for several decades. He is considered a leading authority in these two fields, and this prominence has resulted in invitations to visit several foreign countries to consult with members of the dairy industry regarding manufacturing problems.

O. F. Hunziker

O. F. Hunziker was born in Zurich, Switerland, December 25, 1873. The fact that his father was a minister and later a professor of pedagogy at the University of Zurich no doubt had considerable influence in shaping the life of young Otto.

While still a boy, this future dairy leader manifested an interest in farm work and spent his spare time associating with dairy farmers. At the age of 19, he graduated from an agricultural college. Luckily for the dairy industry of the world, young Hunziker aspired to go to America. In 1893 he left for this promised land and settled on a dairy farm near Attleboro, Mass., where he received the magnificent salary of $5 per month plus room and board.

In 1895 he left the farm in order to obtain more education and enrolled in a 1-year commercial college course at Providence, R. I. After graduation, he went back to Switzerland but soon decided to return to America. At the age of 25 he entered Cornell University, specializing in dairying. He graduated with honors in two years, and a year later received his M.S. degree.

After a year on the staff at Cornell, Mr. Hunziker obtained a position in a condensed milk plant at Ellicottville, N. Y. This was an important step in his life, for here he not only began laying the foundation for his proficiency in the field of condensed milk manufacturing but he met and married Florence Bell Burne. To this union were born three sons and three daughters.

In 1905, Mr. Hunziker accepted a position at Purdue University and two years later was made head of the department. His program of research work and training of young men led to the recognition of the Purdue Dairy Department as one of the best in the country. He has made many contributions to the dairy field, among which might be mentioned the standardization of Babcock glassware, the effect of metals on quality of milk products, a study of the keeping quality of storage butter, and a determination of the cause of mottles and fishy flavor in butter.

In 1917, industry beckoned to Professor Hunziker and enticed him from the University to accept the position of manager of the manufacturing department of Blue Valley Creamery with headquarters in Chicago. Here the thorough manner in which he always proceeded in his work soon led to the development of new and more efficient methods of processing cream and the churning of butter. A number of patents were issued to him for methods developed under his supervision, such as the deodorizing of cream.

In recognition of his scientific achievements many honors have been bestowed upon Professor Hunziker aside from being selected as one of the ten master minds of dairying. For scientific publications at the International Exposition at Milan he was awarded a diploma by the Italian government. In 1927, the Australian Dairy Council honored him for services rendered at dairy conventions in that country. The following year the Swiss government gave him a gold medal. In 1934, A.D.S.A. presented him the Distinguished Service Seroll. The Brazilian Instituo—Technico Industrial issued him the "Grande Diploma de Honra" in 1942. Spain awarded him an honorary membership in "Tu Sociedad Espanola de Bromatologia" in 1950. Purdue bestowed an honorary Doctor of Science on him in 1932. He served as official delegate to six International Dairy Congresses (1911, 1928, 1931, 1937, 1949, and 1953).

In spite of the many honors that have been bestowed upon him, Dr. Hunziker is a very humble and modest man, who gives generously of his time to his church and his community. He is a member of the official board of the First Methodist Church of LaGrange, Ill., and of the board of directors of the LaGrange Fed-

eral Savings and Loan Association. He is a member of the Civic Club and the Kiwanis Club of LaGrange, and the American-Swiss Chamber of Commerce of Chicago. Water sports, mountain climbing, ice skating, and gardening are his hobbies.

One of the most important distinctions held by Professor Hunziker and one that he is very proud of is the fact that he is a charter member of A.D.S.A. He has faithfully served the Association ever since its beginning. In 1911-12 he was president. He has been a member of the Journal Management Committee and an associate editor of the *Journal*, and has served on many committees.

For nearly 54 years Professor Hunziker has been a faithful worker in the industry he learned to love as a young boy in Switzerland. He has made numerous contributions to the industry and community life of his country by adoption. He has unselfishly given of his time and energy to advance the welfare of dairying the world over. He has lived a full and useful life. To Otto F. Hunziker a toast for a successful life that will serve well as an inspiration for the young men in dairy science for years to come — truly a great pioneer in our industry.

Penn State Making Plans for Annual Meeting

The entire dairy staff at Penn State is busy making arrangements to handle the large number expected on the campus June 22-24, 1954. The general committee handling the task of coordinating the 49th Annual Meeting is headed by F. J. DOAN, Professor of Dairy Manufacturing. Other members of this committee are D. V. JOSEPHSON, C. D. DAHLE, R. H. OLMSTEAD, C. R. GEARHART, AND J. O. ALMQUIST.

A general announcement covering the meeting plans will appear in the April issue of the Journal. Special mailings to members of the Association will cover registration, housing, meals, programs and entertainment, as well as information about the university and state, including a special tours map.

Short Courses Scheduled at Virginia Polytechnic Institute

Dairy Laboratory Technicians' Short Course:
Introductory course—February 8-13
Advanced course—February 15-20

Ice Cream Conference and Clinic—February 24-25

Cottage Cheese and Buttermilk Conference and Clinic—March 17-18

Diversey Acquires Sanitary Products, Ltd.

The Diversey Corporation has announced that its Canadian affiliate, The Diversey Corporation Ltd., has purchased controlling interest in Sanitary Products, Ltd. of St. Johns, Newfoundland, a distributor of hotel and restaurant supplies and industrial and maintenance materials. New warehouse facilities are being erected immediately, and manufacturing facilities are contemplated.

Officers and executives of Sanitary Products, Ltd. will continue in their present capacities. N. P. MAXWELL is Managing Director.

Western Division Holds Annual Meeting

The annual meeting of the Western Division ADSA was held at Colorado Agricultural College, Fort Collins, July 27-29, 1953. The following papers were presented:

"Comparative digestibility and feeding value of vetch and oat silage preserved with dried molasses beet pulp and with sulphur dioxide," I. R. JONES, J. H. BYERS, JOHN SCHUBERT, and B. F. MAGILL, Oregon State College.

"Effects of feeding chlordane- and aldrin-treated alfalfa hay to lactating dairy cows," G. E. STODDARD, G. Q. BATEMAN, C. BIDDULPH, L. SCHUPE, J. R. HARRIS, F. V. LIEBERMAN, D. A. GREENWOOD, and L. E. HARRIS, Utah State Agricultural College.

"Genetic and environmental changes in fat production in the University of Idaho Holstein and Jersey herds," W. R. HARVEY, Univ. of Idaho.

"The importance of judges, heifers, and ages in causing variation in type ratings of young dairy heifers," W. R. HARVEY, R. H. ROSS, and D. L. FOURT, Univ. of Idaho.

"Influence of method of feeding dried whey on control of scours and on growth of calves to 60 days of age—progress report," D. C. BROWN and H. S. WILLARD, Univ. of Wyoming.

"The pattern of return services of cows bred artificially with semen from clean and trichomoniasis-infected sires," L. R. HUNSAKER, Utah State Agricultural College.

"The pH of bull semen and the vagina of cows as related to fertility," P. C. BERGER, I. R. JONES, and J. H. BYERS, Oregon State College.

"Semen and fertility studies of bulls receiving variable carotene intakes," J. H. BYERS, I. R. JONES, and P. H. WESWIG, Oregon State College.

"Some causes of variation and covariation in fat and solids-not-fat percent of milk from Holstein cows (abstract)," CLAYTON GORRIE and W. R. HARVEY, Univ. of Idaho.

"Undecorticated safflower meal for milk production—A progress report," R. H. Ross, G. W. Cleveland, and D. L. Fourt, Univ. of Idaho.

"The use of the protein test (formol titration) to estimate the solids-not-fat content of milk," G. A. Richardson, J. O. Young, S. H. Dalal, S. J. Pearce, and P. N. Narula, Oregon State College.

The Western Division sponsored Intercollegiate Dairy Cattle and Dairy Products Judging contests were held in connection with the Pacific International Livestock Exposition in Portland, Oregon, October 20, 1953. The State College of Washington ranked first in dairy cattle, and the Univ. of Idaho took high honors in dairy products.

Officers elected for the coming year are: G. M. Drumm (California Polytechnic College), chairman; J. O. Young (Oregon State College), vice-chairman; L. R. Hunsaker (Utah State Agricultural College), secretary-treasurer.

A.D.A. of Utah Holds Annual Meeting

The 18th annual meeting of the American Dairy Association of Utah was held Nov. 27 and 28 at Salt Lake City. At the same time the different breed associations of the state held meetings. Among those who addressed the group were M. N. Warnick, president, and L. J. Will, manager of A.D.A.; M. K. Swanton, executive secretary of the Wisconsin Council of Agriculture; and R. J. Werner, executive director, Milk Industry Foundation, Washington, D. C.

In the course of the meeting it was revealed that the number of dairy cows in Utah in 1952 was 102,000 as compared with 103,000 in 1940. The amount of milk production increased, however, from 550 to 673 million pounds. The cash receipts from farm marketing of dairy products was $41,185,300 in 1952, as compared to $39,973,000 for poultry and eggs, $32,200,700 for cattle and calves, and $20,841,000 for sheep and wool lambs. The total cash receipts from farm marketing in Utah in 1952 was $179,905,000.

Of the 557 million pounds of milk purchased by dairy plants in 1952, 53% was grade A. From the milk and cream of Utah farms, 112 factories manufactured the following in 1952:

Butter	4,465,000 lb.
Cheese	10,233,000 lb.
Cottage cheese, creamed	4,776,000 lb.
Evaporated milk	60,119,000 lb.
Nonfat dried milk solids	4,783,000 lb.
Ice cream	2,741,000 gal.
Ice milk	640,000 gal.
Sherbet	99,000 gal.

Utah Has Short Course

The Utah State Agricultural College held a meeting for dairy fieldmen, inspectors and D. H. I. A. supervisors, Nov. 5 and 6 with Professor L. R. Rich as chairman. The major points of discussion had to do with antibiotics and dairy calf feeding, housing of dairy cattle, brucellosis eradication, and bulk handling of milk in tanks.

Completed Theses

M.S. Degree:

W. T. Ezzard—Effect of certain germicides in sanitizing teat cup inflations of milking machines. Univ. of Georgia.

P. C. Hintz—Free amino acids and free fatty acids in Swiss cheese. The Ohio State Univ.

R. A. Reisfeld—Factors affecting the manufacture of low-fat soft-ripened cheese. The Ohio State Univ.

Ph.D. Degree:

I. S. El-Hagarawy—Factors affecting the organic acid production by propionic bacteria used in the manufacture of Swiss cheese. The Ohio State Univ.

Illinois Student Survey Reveals Interesting Facts

Information recently gathered from registration records in the College of Agriculture at the Univ. of Illinois are of interest. Some pertinent facts taken from this study are as follows:

Student enrollment by curricula

Curriculum	Total for *1952-53*	*1953-54*
Agricultural Science	64	50
Dairy Technology	23	20
Floriculture	35	41
Food Technology	11	13
General Agriculture	655	639
General Agriculture, Teacher Training	101	111
Home Economics	301	291
Home Economics, Education	77	65
Pre-Forestry	11	17
Restaurant Management	16	14
Total	1,294	1,261

The enrollment for 1953-54 is 200 less than it was in 1950-51, the principal difference being in the number of juniors and seniors.

In 1935, 73% of the freshmen came from the upper half of their high school graduating classes; in 1953, 79%. In 1953, 45% of the agricultural freshmen were in the upper quarter of their high school classes.

Forty percent of the entering freshmen in 1953 had scholarship help. Only 21% indicated their parents were paying all their expenses, and 48% stated they were getting some help

from home. The remainder (31%) stated they were paying their own way through college with savings or earnings from current jobs (14% mentioned earnings only).

Approximately 44% of the freshmen entering college in 1953 indicated that they planned to become farmers. In 1950 a survey made of the alumni showed that less than 20% of the graduates actually became farmers.

No conclusions were drawn from this study. Possibly the data are too few and too limited to be significant. However, there are a few points that seem important. Academically, the freshmen agriculture students rank high among their high school graduating classes. The agriculture students to a large extent work for at least a part of their college expenses. For some reason, going to college results in a number of agricultural students changing from their original objective of being farmers. There is a lack of interest on the part of students in the technology of food industries. The total number of students registering in the colleges of agriculture is on a decrease, particularly in the junior and senior years; this may account in part for the decreased number of students in dairy and food technology.

Claybaugh Joins Mead Johnson

G. A. CLAYBAUGH has recently joined the bacteriological control division of the Mead Johnson Research Laboratories, Evansville, Ind. Dr. Claybaugh graduated from the Univ. of Nebraska and received his Master's degree from Michigan State College. He received his Ph.D. degree in dairy bacteriology from Iowa State College.

Pinotti Elected Vice-President of Kimble Glass

F. D. PINOTTI has been elected a vice-president and member of the board of directors of Kimble Glass Co., subsidiary of Owens-Illinois Glass Co. Kimble is one of the leading producers of scientific glassware used in the testing laboratories of dairies, pharmaceutical firms, and industrial research departments.

A native of Vineland, N. J., Mr. Pinotti joined the Kimble Glass Co. plant there in 1934 as a chemical engineer. Later, he was named assistant to the Director of Research, then Assistant Chief Engineer, and in 1951, Chief Engineer, a title he retains along with that of assistant to the General Factories Manager. He was graduated from Bucknell University in 1934.

Ralston Purina Company Announces Research Fellowship Awards

School Year July 1, 1954—June 30, 1955

Objective: to assist in the training of additional personnel for furthering the interests of agriculture, particularly the livestock and poultry industries.

Awards will be made in the fields of (1) nutrition and physiology research as applied to dairy, poultry and animal husbandry; and (2) research in transmissible diseases of livestock and poultry. Any person qualified for graduate study in any Land-Grant agricultural college or approved veterinary college (including Canadian colleges) who possesses desirable personal qualifications and submits a completed application may be eligible. The application and necessary requested information must be in the hands of the Awards Committee by March 1 of the year the award is to be made.

Research fellowships will be awarded on an annual basis. The recipient of an award may be eligible for appointment not to exceed a tenure of 3 years. Not more than 10 research fellowships shall be awarded annually, as follows: not more than three each in dairy husbandry, animal husbandry, and poultry husbandry; and not more than one in the field of veterinary science. The selection of the recipients of the awards, as well as the rules governing the awards, shall be made by a committee of an officially appointed representative of each of the following organizations: Poultry Science Association, American Veterinary Medical Association, American Dairy Science Association, American Society of Animal Production, Association of Land-Grant Colleges, and the Ralston Purina Company.

Amount of Fellowship—$1,560.00 annually.

Application blanks for these fellowship awards may be obtained by writing the Ralston Purina Research Awards Committee, c/o J. D. SYKES, Ralston Purina Company, St. Louis 2, Missouri.

Meetings Held at Oregon State

The annual Milk Sanitarians Short Course was held at Oregon State College November 30–December 2, 1953. The short course is sponsored by cooperative efforts of the Oregon State Department of Agriculture and Oregon State College. C. J. BABCOCK, in charge, Standards Section, Dairy Branch, P.M.A., Washington, D. C., gave several presentations during the meetings.

The Oregon Association of Milk Sanitarians held a dinner meeting December 1 at Corvallis. VIRGIL SIMMONS, Division of Foods and Dairies, Oregon State Department of Agriculture, was elected president of the organization for the coming year.

The 43rd annual Oregon Dairy Industry Short Course and convention will be held February 15 to 18, 1954, in Withycombe Hall at Oregon State College.

Knott Appointed to Dairy Advisory Committee

J. C. KNOTT, Director, Institute of Agricultural Sciences, State College of Washington, has been appointed by Secretary of Agriculture, Ezra Taft Benson, to serve on the Dairy Advisory Committee, filling the vacancy created by the resignation of P. F. SHARP. This committee serves in an advisory capacity to the Agricultural Research Administration, U.S.D.A., on subjects relating to dairy research.

Dr. Knott is a former staff member of the Department of Dairy Science, State College of Washington, and a former director of the A.D.S.A.

Industry Meetings at Ohio State

A Market Milk Short Course was held November 9-20. Twenty-one persons completed the course. An Ice Cream Short Course was held January 11-20.

The 21st annual Dairy Technology Conference is to be held February 9-12. The theme for this year's program is "Efficiency is the result of organized knowledge." The following topics will be featured: *butter and cheese*—quality and composition control, waste disposal and new types of cheese; *fieldmen*—farm practicums of interest to fieldmen and modern developments of farm milk handling; *market milk*—preventive maintenance programs for dairy equipment and sanitation practices; *ice cream*—a clinic on fruit ice cream, new ingredients, and new production methods.

Symposium on Instrumental Analysis

The Chicago Section of the Instrument Society of America has scheduled a 2-day symposium on methods of instrumental analysis, to take place on Feb. 1 and 2, 1954.

Papers have been scheduled on the following subjects:

Measurement of pH.
Measurement of solution conductivity.
Amperometric analysis and polarography.
Colorimetry, nephelometry, and fluorimetry.
Infra-red analysis and spectrophotometry.
Spectrophotometry in the visible and ultraviolet.
Optical polarimetry and saccharimetry.
Electrophoresis (tentative).

The material to be presented is to deal with principles and methods, rather than with equipment. Errors, their causes, their prevention, and methods of checking will be emphasized. The symposium is aimed at the group leader level and should be of interest to supervisors, research workers, and to group leaders in general.

It is planned that printed proceedings, containing all material presented, will be available to every registrant. To defray the cost of preparing these, a registration fee will be charged.

Advance registration is requested whenever possible, to permit the provision of enough facilities. Registration may be made with either R. KINKAID, c/o Beckman Instruments, 7145 W. Belmont, Chicago 34, or H. C. ROBERTS, 511 W. Washington, Urbana, Ill.

Arizona to Hold February Meeting

The Univ. of Arizona will hold its third annual Dairy Industry conference Feb. 25 and 26. Outstanding speakers from industry and university circles have been invited to participate in the program.

Former Illinois Dean Dies

H. P. RUSK, Dean of the College of Agriculture and Director of the Experiment Station and Extension Service at the Univ. of Illinois from 1939 until his retirement in 1952, died January 9 after a long illness. From 1922 until he assumed the deanship, Professor Rusk was head of the Animal Husbandry Dept. at Illinois. A graduate of the Univ. of Missouri, he served on the Animal Husbandry staff of that institution, as well as at Purdue Univ., prior to joining the Illinois faculty in 1911.

During his undergraduate days, Dean Rusk assisted in founding the first chapter of the Farm House fraternity. He served as chairman of the Agricultural Task Force of the Hoover Commission for the reorganization of federal agencies during the Truman administration.

Dean Rusk was born on a farm near Rantoul, Illinois, in 1884. He is survived by his wife and two daughters.

LETTERS TO THE EDITOR

Discussion Session for A.D.S.A. Meetings

Should an additional objective be included in our A.D.S.A. programs? Each year group discussions in the hall compete quite successfully with the formal program. Usually, and quite appropriately, the members of these groups are discussing mutual problems in the hope of acquiring new ideas for future research (or to achieve better integration of effort). Why shouldn't the Association recognize this means of improving research by reserving at least an hour toward the end of the program for evaluating a few of the more popular fields of research reported on during the regular meetings and to chart future plans? Wouldn't it be time well spent if we sat down after all the reports have been given to briefly outline points

of disagreement, agree on unsettled questions, and suggest new techniques which could profitably be used in the future?

Let's not be so naive as to expect our fellow workers to reveal blueprints of their future plans, but in many instances we should be able to agree on common techniques so the differences which do occur could be more readily analyzed. Many workers might receive valuable suggestions which would greatly improve their research. And, last but not least, by letting co-workers know in advance what problems we are most interested in, there should be less unnecessary repetition of research — and better A.D.S.A. programs. At our next meeting why not set aside a brief period to meet and talk over the latest evidences of progress and decide what looks like the most promising approach into the future? Let's depend more on our Journal for reports of current research and use the time saved at our meetings for exchanging the best ideas on future research.

DWIGHT ESPE
Agricultural Research Service
Washington, D. C.

OUR INDUSTRY TODAY

Brief Reviews of Current Topics

THE PROBLEM OF DAIRY SURPLUSES

RUDOLPH K. FROKER

Dean and Director

Wisconsin College of Agriculture, Madison

During the first 10 months of 1953 the federal government purchased approximately 350 million pounds of butter, or an average of over a million pounds per day. It purchased 70% as much in those 10 months as in all of the 13 years 1933-41, and 1949-52, leaving out the World War and immediate postwar years 1942-48. Purchases of butter during those 10 months were equal to about three months of domestic consumption at present rates and over two months' supply was still on hand in November.

R. K. Froker

Cheese purchases during the same 10 months totaled 275 million pounds, of which over 90% was still on hand at the end of the period. These purchases were half again as much as those made by the government during the 13 year period just referred to, and equal more than two months' consumption of all types of cheese.

Purchases of nonfat dry milk solids during the 10 months totaled 520 million pounds, or nearly as much as our consumption during that period. About three-fourths of this supply was still on hand in November.

These figures are large, but they take on less striking proportions when we realize they represent the surpluses of the whole dairy industry. Surpluses of milk for fluid milk, cream, ice cream, evaporated milk and other milk products are siphoned off as cheese, butter and powder. Put in that light, government purchases in 1953 represent 7 to 8% of the full year's production, while the stocks on hand in November represent 5 to 6% of that production.

A question that is frequently asked is how government stocks of dairy products compare with those of other farm commodities under price supports.

On November 23 the Commodity Credit Corporation held stocks totaling roughly 250 million pounds of butter, 260 million pounds of cheese, and 425 million pounds of dried milk. The food stocks under this agency also included over 1 billion pounds of other fats and oils, 450 million bushels of corn, and 425 million bushels of wheat.

These stocks, together with those of cotton, tobacco, wool, seeds, and other products, represent a total inventory cost of over 2½ billion dollars, over a third of which was invested in wheat.

Dairy products represent about 10% of the total in government inventories and commodity loans, while dairying makes up about 20% of the national farm income.

The quantity of farm products in storage has greatly expanded during the past year, and it seems obvious that some changes in markets or price support operations must take place. Some changes are now in process, as for example the development of the wheat acreage control and allotment program.

Milk Production Rises Suddenly

Ordinarily we think of milk production as very stable, there seldom being more than 3 to 4% variation in total production from year to year; and the current year will probably prove to be no exception. However, milk production during the past year and a half has fluctuated in a very unusual way. In the summer of 1952 it was at the rate of 110 billion pounds per year, but suddenly increased to a rate of 123 billion pounds in the late fall and winter—the sharpest rise ever to take place in that short a period.

The industry up to then had a fairly tight supply-demand situation, but it quickly changed to large surpluses even in the ordinarily low-production season of the year. During the summer of 1953, milk production dropped back slowly toward its former level with pasture conditions generally much below normal.

Four factors largely explain the rapid rise in production during the fall of 1952:

1. The decline in beef prices caused many farmers to retain a larger proportion of their milking stock.
2. There was a near-record supply of good quality hay and concentrates, which were fed at record levels.
3. Weather throughout the fall and winter was unusually mild for the nation as a whole.

4. The relatively sharp drop in cash receipts in other farm enterprises induced many farmers to milk cows who did not do so when cash incomes were higher. It has long been the practice for many people with dual purpose cows to keep them primarily for beef when beef is high but to milk them when dairying pays better.

Looking to the future, it may be important to note that in 1953 milk cow numbers reversed their downward swing for the first time in several years and registered a 2½% increase over 1952. There also may be significance in a 4% increase in heifers 1 to 2 years old being kept for milk and a 5½% increase in heifers under 1 year of age being kept on farms.

It would be easy to attach too much importance to these figures, since they may be changed significantly if we have a continuation of the very widespread and severe drought that has prevailed in several areas this past summer and fall. On the other hand, these production and supply figures cannot be overlooked.

Consumer Preferences Have Changed

To understand the dairy surplus problem, we need also to look at the consumer end of the marketing system and to divide milk into its two major parts—fat, and nonfat milk solids.

The most striking and far reaching development on the consumer side is a general weakening in the demand for milk fat, especially for butter. This is shown both in prices and in quantities consumed. It is one of the most important changes affecting the dairy industry during the past half century.

In the 1930's about 45% of the milk fat used for human consumption in the United States was made into farm and creamery butter. In 1953 only about 20% is used for butter. The average American is eating only about half as much butter now as before World War II. People do not buy milk on the basis of the cream line as they did some years ago. Cream even seems to be disappearing from coffee; more people take it black these days.

Products which use nonfat milk solids, either alone or in combination with milk fat, have a better consumption record. Since 1935-39 the per capita consumption of fluid milk and cream (mostly fluid milk) has gone up about 20%, cheese 50%, ice cream 85%, and nonfat dry milk solids more than doubled. Obviously, with these per capita changes and the rapid increase in population, the over-all market has broadened substantially for the nonfat milk solids, although, as we shall see, supplies have also increased.

Farmer Sales Have Changed

Since 1935-39 milk production has increased about 10%, but this is only part of the production problem. Sales of whole milk from farms to plants and dealers during this period rose nearly 70%, with some offsetting decline in retail sales of milk and cream by farmers.

There has been a tremendous shift from farm separated cream to whole milk sales. More of the skimmilk once fed to livestock is now absorbed in products for human consumption.

Dairying's surplus problem, therefore, is not simply how to absorb a 10% increase in production since 1935-39. When all factors are taken into account at the producer and consumer levels we find about a 30 to 40% adjustment in both fat and nonfat solids in the past 15 years. It is not surprising that dairying has not been as profitable as have some other agricultural enterprises in recent years, or that we face a critical market situation at the present time.

Important Decision to Make

Dairymen and others are concerned about the right level at which to support milk and butterfat prices. The changes just described show something of the difficulty in making that decision. Should production conditions be unfavorable, we might be glad to have all available supplies, including accumulated stocks. The decision is particularly important with respect to the level of supports for butterfat, which in turn means butter prices. The price ratio of butter to margarine has never been less favorable for butter. There are enough vegetable oils and fats on hand to make more than a billion pounds of margarine.

The butterfat question is the dairy problem that concerns us most. The whole fats and oils situation presents a very difficult problem. The cotton folks recently agreed to a reduction in the support level of cottonseed oil from 90 to 75% of parity because they were losing out to soybean oil and had accumulated stocks from 1951 and 1952 as well as the current year. The soybean committee, in turn, is looking at the over-all fat and oil situation to decide whether it is to the long-run interest of the industry to maintain supports at present levels.

Less Emphasis on Fat

The dairy industry is on safer ground putting its main emphasis on whole milk and whole milk products and relatively less on milk fat—in production, in dairy product promotion, in pricing plans, and in price support programs. For a time this may mean surplus problems that are fully as difficult as the ones we now face, but it is to the long-run interest of the industry and the public.

There has been much discussion in recent months as to whether federal milk orders are complicating the present dairy situation by keeping prices in fluid markets too high, thus stimulating production and adding to the surplus.

The evidence seems to be quite clear that prices have been kept relatively higher in fluid milk markets than in other parts of the industry. But the increased production over the past year has not been confined to the fluid milk areas. Pastures and local feed conditions enter into production as well as price. The National Dairy Advisory Committee has a subcommittee studying the federal orders with special attention to their effects on production and consumption.

Commodity Approach Has Limitations

There is real danger in trying to solve surplus agricultural problems on a piecemeal or commodity basis without giving enough attention to the over-all problem. We may seem to be solving a problem when actually we are only moving part of it from one branch of the industry to another or from one commodity to another. To take a current example, if 30 million acres are taken out of wheat, cotton, and corn under acreage controls, these acres are likely to be shifted to soybeans, feed grains, and grasses. That, in turn, means more competition in the livestock field.

How can our present surplus stocks of agricultural products be moved into consumption?

First, by selling stocks back to commercial handlers for normal use. Some sales of this type are made from time to time, but this method has limited possibilities as long as abundant supplies are pressing on the market. On the other hand, surplus stocks have real value as a reserve against national emergency. The surpluses accumulated prior to World War II were most useful during that conflict.

A second method of disposal is through school lunches, to public welfare agencies that help needy people within this country, and to private welfare organizations that help needy persons both within this country and outside the United States. Sizeable quantities of foods have been used for school lunches and for needy persons here and abroad.

Some considerable sales of butter and dry nonfat milk solids, over and above usual amounts, have also been made at reduced prices to our armed forces.

Still another method of disposal which has received relatively little attention until recently is what is known as section 550, under which the President is authorized to enter into agreements with friendly countries for the sale and export of surplus agricultural commodities and to accept in payment therefor the local currency of these countries. From 100 to 250 million dollars have been authorized to finance such sales.

I believe added effort will be, and should be, made to expand our exports of surplus farm products. Exports of farm products this past year dropped nearly a third, and this backing up of supplies is one of the principal factors in the present farm price situation.

The importance of developing markets here and abroad can hardly be over-emphasized as an alternative to cutting production and to purchase and storage of surpluses. Unhappily, markets are not easily expanded. Our foreign trade is tied in with our international policies, monetary programs and defense.

Factors Favorable for Future of Industry

Three of the most favorable factors in the dairy picture are:

1. *The U. S. continues to have a high level of domestic employment and high consumer incomes.* For the first six months of this year consumer incomes after taxes were up 7% over the same period a year ago. This alone is no guarantee of satisfactory farm income, but without full employment and high purchasing power the farm price and income problem would be much worse.

2. *Dairy products are a cheap source of nutrients for the human diet.* A study made earlier this year in California showed that 18 to 20% of the family food dollar was spent for milk and other dairy products. These 18 to 20 cents of the food dollar bought for the members of the American family:

23–26% of their calories
40–45% of their protein
75–84% of their calcium
59–76% of their riboflavin
35–39% of their vitamin A
18–19% of their thiamin, and
5– 6% of their iron and niacin.

Thus the dairy industry has one of the best and most economical of all foods, but it still has a big job ahead in selling.

3. *Our population is increasing rapidly which means a larger and larger domestic market for milk products.* Each day there are 7,000 to 10,000 more customers. This is like adding a city the size of Chicago every year, without any additional agricultural resources.

These are conditions which give rise to market optimism as one views the longer term dairy and agricultural outlook. It is also good to know that with these additional millions to feed there is some extra food in the larder and that we have a healthy, productive agriculture.

Price Supports Necessary

Our price problem, then, is to manage our food production and stocks until our population and markets catch up, and at the same time work out ways of maintaining farm incomes at reasonable levels.

The price program is likely to undergo changes from time to time as it has in the past, and it is likely to be a compromise of several proposals. But the objective is clear: We need to strive for more price and income stability in

agriculture and for a larger share of the national income.

In working towards that objective the dairy industry is going to need the aid of price or income supports and all of the self-help that farmers and their cooperative organizations can provide. Let's not think of either price supports or self-help to the exclusion of the other, but of a farm program that makes use of both wherever and to the extent needed.

RECRUITMENT AND TRAINING OF COLLEGE GRADUATES IN THE DAIRY INDUSTRY

Description of a Program That Has Proven to be Successful

WALLACE JAMIE
General Personnel Director
Carnation Company

For several decades Carnation Company has been visiting colleges and hiring a limited number of men for training programs in certain areas of organization. In recent years this program has been broadened. For each of the last four years representatives working out of the Los Angeles world headquarters office, supplemented by key men in the divisions, have visited more than 35 colleges at least once a year and interviewed upwards of 1,000 students to recruit 40 to 60 people for ten different trainee assignments.

Training Programs Cover Three Fields

Training programs are in the fields of Sales, Production, and Accounting-Office Management. For the last two years there has also been a concerted employment of junior chemists for laboratory assignments at Carnation's new research center. The on-the-job instruction lasts for from 9 months in one program to 2 years in several others. Five of the programs are in sales, four are in production (manufacturing), and one is in accounting and office management. The sales training breakdown is (1) Sales of Evaporated Milk, U. S. and Canada; (2) Sales of Fresh Milk and Ice Cream; (3) Sales of Farm Feeds (Albers Milling subsidiary); (4) Sales of Breakfast Cereals (also Albers); and (5) Sales of Evaporated Milk overseas (General Milk Company affiliate). The production training programs follow the same classification except that milling production embraces both feeds and cereals so there is one less program. The training opportunity in the Accounting-Office Management field is for assignment in the Fresh Milk and Ice Cream Division of Carnation.

Students Receive Practical Instruction

The training provides a carefully devised indoctrination for the selected men in the areas of the organization to which they are assigned.

FIG. 1. Round table discussion of trainees with research chiefs.

While no classroom type instruction is provided, the programs are formalized in the sense that the students are exposed to a sequence of experiences calculated to provide a thorough grounding in the functioning of the section of the company to which they are assigned.

For example, in the operating department of the Evaporated Milk Division, the trainee actually performs each of the plant operations in a condensery and many in a can factory in the 24-month learning experience. In this period he is assigned to four different plants, undertakes field work (with farmers), laboratory work, and engineering assignments in addition to regular production functions.

In the Evaporated Milk Sales Department, the student works with salesmen, medical specialists, and malted milk and dog food specialists. In addition, he has retail grocery experience and works in an evaporated milk plant. He then undertakes actual work in a sales territory.

FIG. 2. Laboratory lessons for Carnation trainees.

In some of the programs the trainee is given special reading assignments of professional articles and other material on which he reports. In each of the training programs a series of reports is made on the trainee and his progress by successive supervisors, and a centralized record control in the General Personnel Department assures management of quarterly intelligence on trainee progress.

Technical Knowledge Alone Not Enough

The objective of the program is to develop supervisors and management people. The training is aimed first at supplying a well-rounded exposure to the necessary skills and knowledge of all the jobs in a given division and then early experience in a supervisory position. The ability to supervise—skill in handling people—is of critical importance. Lack of such skill results in the greatest number of casualties. Ample technical knowledge alone will never insure success.

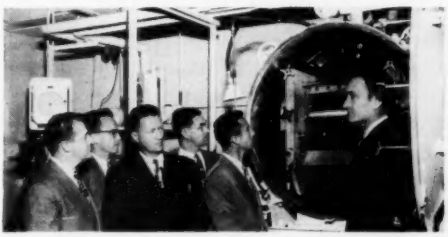


FIG. 3. Dr. Oberg explains research results to trainees.

The average length of a training program is almost 18 months, and there are approximately 70 trainees on the rolls at a given time. A conservative estimate of the cost of training, allowing for divergent degrees of productivity of the trainees (this of course varies with length of time on the job and nature of the program) is $5,000 per year per man. Thus, the cost per year of 70 trainees would be $350,000.

Is It Worth the Cost?

What are the advantages in recruiting men with special training and bright potential and lavishing costly training on them? In general terms, of course, the answer is that broadly qualified management people are being provided for tomorrow. In an increasingly complex economic and business environment, more technically qualified men are required not only in the specialized fields of industrial, labor and public relations, but in the broad area of management. A production manager with a college background of engineering, industrial management, economics, and personnel administration who has had a broad overview of the company's operation, including an exposure to the sales department, is likely to be a better man, even if his intrinsic qualifications are no better than the production manager who has had none of these special exposures. The Sales Manager with solid collegiate training in marketing, statistics, sales-research and human relations, who has had on-the-job experience with a selected group of qualified specialists, who has worked briefly as a part of his training experience in manufacturing, and who has been exposed to the staff operations of his organization, is surely going to be better implemented than one not so favored.

There May Be a Problem in Morale

In sponsoring training programs, industry in general—and the dairy industry is no exception—has encountered one critical problem. In a few instances, programs have been abandoned because this problem has become so serious. Internal morale problems may develop because a feeling is generated among employees that the trainee group is a chosen coterie, membership in which is prerequisite to success. Such an impression can have devastating implications. There are several ways in which to combat it. Most basic of these is to transfer rank and file employees to the training programs whenever such a move seems logical. A man whose abilities and loyalties are demonstrated, who has been a good performer and who has had qualifying experience with the firm is certainly deserving of the cherished billet.

Next, management must in effect say to the nontrainee—and mean it—that when a supervisory job opens, the qualified man available will be selected for it. Often this may be the proved, efficient worker and not the collegian. Third, recruitment of trainees who have personalities not likely to gain an untoward reputation for the group, is an important consideration. Genuine, hard-working, modest, friendly, capable chaps who know the real meaning of humility, are less likely to engender animosities and strains in the organization than immature youngsters on whom the badge "trainee" is conspicuous. One of the latter type who tends to "throw his weight around" can be a costly commitment. Finally, when feasible, geographic movement of the trainee in the course of his training experience, which, of course, has real value from other standpoints, can be helpful in reducing the frictions which a training program almost inevitably engenders. At the point of second assignment the student is no longer the blundering neophyte, and it is easier for his coworkers to watch him progress without a sharp sense of jealousy. Many trainees in both sales and manufacturing are transferred as often as four times in the course of two years of instruction. They are thereby afforded a chance to discover different problems which divergent areas present; the salesman encounters different market conditions, the production man, varying local problems in manufacture.

Not All Trainees Succeed

In the course of the years, a substantial number of trainee recruits have fallen by the wayside. This experience is not different from that of other companies and other industries. An attempt is made to provide in initial interviews a realistic picture of the experiences that lie ahead. The industry and the opportunity are

not glamorized. Perhaps the program is even undersold. An assured, if unspectacular, career with good long-range opportunities is described. "Jet propelled" candidates are shunned. The virtues of employment in a noncyclical field are described. Commitments are not made on the campus.

Recruiting Carefully Planned

The normal recruitment procedure follows this pattern; university staff people (Placement Office, Agriculture School, Business School, etc.), advised of opportunities in the company, schedule a selected group for interview by representatives of the General Office staff who visit the campuses twice each year. An investigation of the candidate's school and work record and a short set of psychological tests professionally selected, developed and graded, all figure in a decision whether or not to invite the student to visit an appropriate plant or office at company expense. There, multiple interviews by high level people in the division interested in the candidate carefully evaluate him while he, in turn, is afforded a chance to appraise the setting in which he would be working and the type of people with whom he would be associated. If the student has a wife, she is invited into the recruitment picture at some stage.

Number of Available Candidates Has Decreased

College recruitment this year and last has been unprecedentedly difficult for several reasons. About 80% of the bachelor's degree candidates from most colleges are entering the service, 10% are going on with advanced study, 5% have lined up their own jobs, so only about 5% are able to talk with the industry about present employment in the trainee billets available to them. Even though students are scheduled for military service upon graduation, they should be interviewed if amenable. Already, the value of such meetings undertaken two years ago has been shown. Upon return from service several such men have remembered the company and have renewed the contact made at college.

There is a growing awareness of the value of bringing college people into industry, and this, added to the military situation, accentuates the hiring problem and has resulted in disproportionately high initial salary offerings. Moreover, in the agricultural areas, and particularly in dairying, the recruitment problem is probably manifest in its most acute form, for the field has not attracted the numbers and the quality of students which it merits.

The Program Has Succeeded at Carnation

Notwithstanding the substantial cost of training and the conceivable internal problems which bringing in a special outside group involves, the Carnation Co. is "sold" on the value of such programs. Such training has been sponsored long enough to bear fruit. Throughout the Company—in sales, production, accounting, office management, and in overseas operation—there are individuals who have come up by the trainee route who are now impressively administering important sections of activity. The problem is to maintain the desired number of suitable candidates.

Dairy Industry Needs to be Sold to College Men

While it is possible for the recruiter in the dairy industry to look broadly throughout college departments for certain of his selectees, the industry requires a certain number of dairy specialists, and of these there is a sparse supply of interested candidates. The low birth rate of the '30's can no longer be ascribed as the basis for the paucity of people studying dairy manufacturing and related subjects. Plainly, the field has not been "sold" as it should have been and might be. Career horizons in dairying are fully as appealing as those in fields which are attracting more students, but the vocational counselor in the high school is apparently not "selling" our industry in the way it deserves. Many of our largest and best universities are turning out fewer than 10 or 20 dairy manufacturing majors a year. Often many such graduates remain on campus to undertake research or to prepare to teach.

The dairy industry can do a great deal toward publicizing the attractiveness of careers in its field and bringing more and better students into the college programs. The provision of training programs where the graduates can carry on after graduation and qualify for even greater growth and broader responsibility than would otherwise be possible is surely one solution.

Endowments, scholarships and fellowships furnished by the industry will help. But there undoubtedly are many other responsibilities of which industry should be aware and opportunities which it should be implementing.

ASSOCIATION ANNOUNCEMENTS

LETTER FROM THE PRESIDENT OF PENNSYLVANIA STATE UNIVERSITY

November 18, 1953

Dr. Walter V. Price, President
American Dairy Science Association
University of Wisconsin
Madison 6, Wisconsin

Dear Dr. Price:

The Pennsylvania State University is happy that the American Dairy Science Association has selected our institution as the site of its Forty-Ninth Meeting on June 22-24, 1954. It is my understanding that your last visit here in June 1936 was a stimulating one. I hope your 1954 meeting will be even more so.

Since your last visit, we have expanded and improved our guest facilities, so that I am confident you will be quite comfortable. Our scientific resources have also been improved to a gratifying degree. Both the Dairy Production Center and the Dairy Cattle Breeding Research Center are completely new. They, as well as other unique research and instructional units on the campus, will interest most of you.

Please accept for yourself and extend to your associates a most cordial welcome from all of us, and my best wishes for a pleasant and profitable meeting.

Sincerely,

MILTON S. EISENHOWER
President, The Pennsylvania State University

PAPERS FOR THE 1954 ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

The 49th annual meeting of the American Dairy Science Association will be held June 22-24, 1954, on the campus of the Pennsylvania State University, State College, Pennsylvania. All members who wish to present papers should submit the titles and two copies of an abstract of each paper not later than March 1 to the Chairman of their Section and an additional copy each to the Vice-Chairman and Secretary of that Section. To be acceptable, an abstract must not exceed 200 words. Terminology used in the abstracts should be understandable by the general reader, according to a resolution adopted in 1951. It is important that titles and abstracts be received promptly, since abstracts of the final program must be made available to the printer in time to appear in the June issue of the Journal. It may be necessary to read some papers by title only, if it is found impossible, because of time limitations, to present them

in their entirety on the section program. The respective section officers are as follows:

EXTENSION SECTION

Chairman: Stanley Gaunt, Department of Dairy Industry, University of Massachusetts, Amherst

Vice-Chairman: E. T. Itschner, Department of Dairy Husbandry, University of Missouri, Columbia

Secretary: George Werner, Department of Dairy Husbandry, University of Wisconsin, Madison

MANUFACTURING SECTION

Chairman: A. J. Morris, Department of Dairy Husbandry and Manufacturing, Utah State Agricultural College, Logan

Vice-Chairman: G. H. Hartman, White House Milk Company, 102 Revere Drive, Manitowoc, Wisconsin

Secretary: W. M. Roberts, Animal Industry Department, University of North Carolina, Raleigh

PRODUCTION SECTION

Chairman: Phillip L. Kelly, Department of Dairy Husbandry, University of Nebraska, Lincoln

Vice-Chairman: R. E. Erb, Department of Dairy Science, State College of Washington, Pullman

Secretary: N. P. Ralston, Dairy Department, Michigan State College, East Lansing

The general program committee believes that no person should present more than two papers, thereby making possible active participation by more members. No title will be considered that is unaccompanied by a suitable abstract not exceeding 200 words in length. It is desired that more contributions be submitted by senior staff members and from the laboratories of industry.

Because of problems in slide projection, it is desirable for speakers to distribute mimeographed copies of pertinent data, together with a brief summary of the paper.

OFFICERS AND COMMITTEES OF THE ASSOCIATION

ASSOCIATION OFFICERS

President.....W. V. Price, Wisconsin
Vice-President.....L. A. Moore, Washington, D. C.
Secretary-Treasurer.....P. R. Ellsworth, Ohio
Journal Editor.....P. H. Tracy, Illinois

ASSOCIATION DIRECTORS

H. B. Henderson, Georgia (Immediate Past President)

I. A. Gould, Ohio (1954)
E. J. Perry, New Jersey (1954)
L. H. Rich, Utah (1955)
N. N. Allen, Wisconsin (1955)
D. V. Josephson, Pennsylvania (1956)
G. W. Salisbury, Illinois (1956)

ASSOCIATION STANDING COMMITTEES

American Feed Manufacturers' Award

T. W. Gullickson, Minnesota, *Chairman* (1954)
H. D. Eaton, Connecticut (1955)
J. W. Thomas, Washington, D. C. (1956)

Auditing

C. L. Blackman, Ohio, *Chairman*
J. F. Cavanaugh, Ohio
J. T. Smith, Ohio

Borden Manufacturing Award

H. L. Templeton, Nebraska, *Chairman* (1954)
S. L. Tuckey, Illinois (1955)
F. J. Doan, Pennsylvania (1956)
B. H. Webb, New York (1957)
G. M. Trout, Michigan (1958)

Borden Production Award

C. F. Huffman, Michigan, *Chairman* (1954)
R. E. Hodgson, Washington, D. C. (1955)
Samuel Brody, Missouri (1956)
J. K. Loosli, New York (1957)
R. B. Becker, Florida (1958)

DeLaval Extension Dairyman Award

C. W. Reaves, Florida, *Chairman* (1954)
H. O. Henderson, W. Virginia (1955)
L. H. Rich, Utah (1956)
Lynn Copeland, Tennessee (1957)
S. J. Brownell, New York (1958)

Historian

G. M. Trout, Michigan

Honors

R. B. Becker, Florida, *Chairman* (1954)
H. A. Bendixen, Washington (1955)
H. B. Henderson, Georgia (1956)

Journal Management

R. E. Hodgson, Washington, D. C., *Chairman* (1954)
J. H. Erb, Ohio (1955)
K. L. Turk, New York (1956)

National Research Council Representative

W. E. Krauss, Ohio (1954)

Necrology

E. S. Guthrie, New York, *Chairman*
R. W. Bell, Washington, D. C.
R. Y. Cannon, Alabama
F. J. Babel, Indiana
R. W. Stein, Oregon

Nominations

R. WHITAKER, New York, *Chairman*

H. B. HENDERSON, Georgia
C. A. PHILIPS, Cailfornia
CHRIS JENSEN, North Dakota
LYNN COPELAND, Tennessee

Program

H. B. HENDERSON, Georgia, *Chairman*

S. N. GAUNT, North Carolina
P. L. KELLY, Nebraska
A. J. MORRIS, Utah
C. R. GEARHART, Pennsylvania

Ralston Purina Research Fellowship Representative

J. W. POU, North Carolina (1957)

Resolutions

J. J. JEZESKI, Minnesota, *Chairman*

S. N. GAUNT, Massachusetts
A. J. MORRIS, Utah
P. L. KELLY, Nebraska
D. J. HANKINSON, Massachusetts

Student Affiliate Chapters

E. L. THOMAS, Minnesota, *Chairman*

I. I. PETERS, Texas
W. L. SLATTER, Ohio
P. M. REAVES, Virginia
F. B. WOLBERG, Oregon

ASSOCIATION SPECIAL COMMITTEES

Condensation of Dairy Curricula Report

H. P. DAVIS, Nebraska, *Chairman*
L. K. CROWE, Nebraska

Cooperation with Regulatory Agencies

W. M. ROBERTS, North Carolina, *Chairman*

A. C. DAHLBERG, New York
J. T. MILES, Iowa

Dairy Remembrance Fund

D. V. JOSEPHSON, Pennsylvania

Dairy Science Teaching Award

C. E. WYLIE, Tennessee, *Chairman*

W. B. COMBS, Minnesota
A. H. RISHOI, Illinois
H. P. DAVIS, Nebraska
S. M. SALISBURY, Ohio
H. B. HENDERSON, Georgia
R. J. WERNER, Washington, D. C.

Dairywide Coordination of Nutrition Research of National Dairy Council Representatives

R. G. HANSEN, Illinois
J. D. INGLE, Illinois

Inter-Society Cooperation of the American Society of Agronomy Representative

L. A. MOORE, Washington, D. C.

Public Relations

I. A. GOULD, Ohio, *Chairman*
R. E. FROST, Illinois
F. J. ARNOLD, Iowa
H. B. HENDERSON, Georgia
H. A. BENDIXEN, Washington
G. E. HOLM, Washington, D. C.

Revision of Constitution

E. L. JACK, California, *Chairman*

I. W. RUPEL, Texas
EARL WEAVER, Michigan

OFFICERS AND COMMITTEES OF THE MANUFACTURING SECTION

SECTION OFFICERS

A. J. MORRIS, Utah, *Chairman*

G. H. HARTMAN, Wisconsin, *Vice-Chairman* — W. M. ROBERTS, North Carolina, *Secretary*

SECTION COMMITTEES

Butter

G. H. WILSTER, Oregon, *Chairman*
N. E. FABRICIUS, Wisconsin
D. L. FOURT, Idaho
C. A. IVERSON, Iowa
CHRIS JENSEN, North Dakota
W. L. SLATTER, Ohio

Curd Tension of Milk

H. E. CALBERT, Wisconsin, *Chairman*

U. S. ASHWORTH, Washington
H. A. HOLLENDER, Indiana
G. A. RICHARDSON, Oregon
C. F. WEINREICH, Illinois

Dairy Products Judging

G. M. TROUT, Michigan, *Chairman*

E. O. ANDERSON, Connecticut
C. J. BABCOCK, Washington, D. C.
P. A. DOWNS, Nebraska
F. H. HERZER, Mississippi

Evaluation of Methods for Determining the Acidity of Cheese Cultures

H. C. OLSON, Oklahoma, *Chairman*

F. J. BABEL, Indiana
N. S. GOLDING, Washington

Nomenclature and Methodology of Milk Proteins

A. M. SWANSON, Wisconsin, *Chairman*

T. F. FORD, Washington, D. C.
R. JENNESS, Minnesota
A. R. KEMP, Illinois
R. McL. WHITNEY, Illinois

Uniform Procedures for Making Acidity Determinations of Fluid Dairy Products

J. G. LEEDER, New Jersey, *Chairman*
F. J. DOAN, Pennsylvania
B. L. LARSON, Illinois
W. C. WINDER, Wisconsin

SPECIAL COMMITTEE

Practical Aspects of the Operation of the Dairy Industry That May be Included in the 1954 Program

G. H. HARTMAN, Wisconsin, *Chairman*

J. H. HETRICK, Illinois
W. C. WINDER, Wisconsin

JOINT COMMITTEE OF THE MANUFACTURING AND PRODUCTION SECTIONS

Antibiotics in Milk

MANUFACTURING

W. A. KRIENKE, Florida, *Chairman*
F. J. DOAN, Pennsylvania
J. C. OLSON, Minnesota
R. P. TITTSLER, Washington, D. C.

PRODUCTION

W. E. PETERSEN, Minnesota
W. D. POUNDEN, Ohio
E. P. REINEKE, Michigan
V. R. SMITH, Wisconsin

OFFICERS AND COMMITTEES OF THE PRODUCTION SECTION

SECTION OFFICERS

P. L. KELLY, Nebraska, *Chairman*

R. E. ERB, Washington, *Vice-Chairman* — N. P. RALSTON, Michigan, *Secretary*

SECTION COMMITTEES

Dairy Cattle Judging

S. A. HINTON, Tennessee, *Chairman* (1954)

M. L. DAWDY, Pennsylvania (1955)
E. E. ORMISTON, Illinois (1956)

Program (ex officio)

P. L. KELLY, Nebraska, *Chairman*

R. E. ERB, Washington — GEORGE HYATT, North Carolina

Resolutions

W. H. RIDDELL, Vermont, *Chairman*

E. E. HEIZER, Wisconsin — I. W. RUPEL, Texas

JOINT COMMITTEES OF THE PRODUCTION AND EXTENSION SECTIONS

PRODUCTION	EXTENSION
Breeds Relations	
R. E. ERB, Washington, *Chairman* (1954)	W. A. DODGE, Vermont (1954)
C. L. NORTON, Oklahoma (1955)	G. C. ANDERSON, Idaho (1955)
G. H. BECK, Maryland (1956)	RAYMOND ALBRECHTSEN, New York (1956)
Dairy Cattle Breeding	
W. J. TYLER, Wisconsin (1954)	RALPH CORBETT, Maine, *Chairman* (1956)
J. E. LEGATES, North Carolina (1955)	E. C. SCHIEDENHELM, Kentucky (1954)
WALTER HARVEY, Idaho (1956)	R. C. FINCHAM, Iowa (1955)
	J. F. KENDRICK, Washington, D. C. (ex officio)
Dairy Cattle Health	
S. W. MEAD, California (1954)	R. G. CONNELLY, Virginia, *Chairman* (1955)
C. F. HUFFMAN, Michigan (1955)	GEORGE WERNER, Wisconsin (1954)
G. H. WISE, North Carolina (1956)	F. J. ARNOLD, Iowa (1956)
Type Classification	
F. W. ATKESON, Kansas, *Chairman* (1956)	LYNN COPELAND, Tennessee (1954)
I. W. RUPEL, Texas (1954)	H. P. EWALT, Oregon (1955)
R. C. FOLEY, Massachusetts (1955)	HILTON BOYNTON, New Hampshire (1956)

OFFICERS AND COMMITTEES OF THE EXTENSION SECTION

SECTION OFFICERS

S. N. GAUNT, Massachusetts, *Chairman*

E. T. ITSCHNER, Missouri, *Vice-Chairman* — GEORGE WERNER, Wisconsin, *Secretary*

SECTION COMMITTEES

Dairy Records

M. E. SENGER, North Carolina, *Chairman* (1954)	IVAN LOUGHARY, Washington (1955)
D. E. VOELKER, Iowa (1954)	J. D. BURKE, New York (1956)
LEO FRYMAN, Illinois (1955)	J. F. KENDRICK, Washington, D. C. (ex officio)

4-H Club

C. W. NIBLER, Nebraska, *Chairman* (1954)

CLARENCE OLSON, North Dakota (1954) — JOHN MORRIS, Maryland (1955)

Resolutions

RAMER LEIGHTON, Minnesota, *Chairman*

C. L. BLACKMAN, Ohio — DELMAR YOUNG, Delaware

Teaching Methods

L. H. STINNETT, Oklahoma, *Chairman* (1955)	H. L. MANN, Pennsylvania (1954)
LAWRENCE JOHNSON, Michigan (1954)	T. E. WILEY, New York (1956)

MEMBERSHIP DIRECTORY

American Dairy Science Association

December 31, 1953

HONORARY

BORLAND, A. A., 310 S. Burrowes St., State College, Pa.
DAVIS, H. P., Univ. of Neb., Lincoln
ELLENBERGER, H. B., 427 Westminster Ave., Orlando, Fla.
FRANDSEN, J. H., Mass. State College, Amherst
GUTHRIE, E. S., Cornell Univ., Ithaca, N. Y.
HAMMER, B. W., 1728 Arlington St., Sarasota, Fla.
HAYDEN, C. C., Ohio Agr. Expt. Station, Wooster
HUNZIKER, O. F., 103 7th Ave., LaGrange, Ill.
PRUCHA, M. J., 1415 Palmetto St., New Smyrna Beach, Fla.
REED, O. E., Bureau of Dairy Industry, Washington, D. C.
ROADHOUSE, C. L., Univ. of Calif., Davis
ROGERS, L. A., Patton, Maine

LIFE

ALTWEEG, C. A., Box 579, Route 1, Escondedo, Calif.
BREED, R. S., 6 Sunset Drive, Geneva, N. Y.
HARDING, H. A., Baileys Harbor, Wis.
HASTINGS, E. G., Route 3, Orlando, Fla.
LARSON, C. W., Tudor Plaza, W. Ferry St., Buffalo, N. Y.
WHITE, G. C., Willowbrook Rd., Storrs, Conn.

ABRAHAMSON, C. E., 45 Queen St., Franklin, Mass.
ACKERMAN, R. A., Dept. of Dairy Husb., W. Va. Univ., Morgantown
ACKERMANN, H. A., Food Materials Corp., 2521 W. 48th St., Chicago 32
ADAMS, C. S., State Dept. of Agr., Olympia, Wash.
ADAMS, J. V., P. O. Box 215, New Albany, Ind.
ADAMSON, M. H., Jr., Adohr Milk Farms Inc., 1801 S. LaCienega Blvd., Los Angeles 35, Calif.
AHLSTROM, WALTER, 1965 Euclid Ave., San Marino, Calif.
AINES, P. D., Jr., An. Husb. Dept., Cornell Univ., Ithaca, N. Y.
AINSLIE, H. R., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
AJA ROSENDO, Calz. de Tlalpan, No. 553, Mexico
AKINS, W. O., Old Home Creamery, Moose Lake, Minn.
ALBERT, J. O., Central Creameries Ltd., Charlottetown, P.E.I., Canada
ALBERTS, RAY, American Dairy Association, 20 N. Wacker Drive, Chicago 6
ALBRECHT, T. W., Dept. of Dairying, Univ. of Tenn., Knoxville
ALBRECHTSEN, RAYMOND, Route 3, Ithaca, N. Y.
ALEXANDER, M. H., Dairy Sci. Dept., Univ. of Ill., Urbana
ALEXANDER, T. G., 4476 Raleigh Ave., Alexandria, Va.
ALFORD, J. A., Dept. of Bact., Miss. State College, State College
ALGER, H. B., 19051 Delores Ave., Birmingham, Mich.
ALLEN, N. N., Dept. of Dairy Husb., Univ. of Wis., Madison
ALLEN, R. S., Chem. Dept., Iowa State College, Ames
ALLISON, W. E., Route 4, Columbia, S. C.
VAN ALLSBURG, R. A., 821 Oakdale St., Grand Rapids, Mich.
ALM, J. V., 1408 Bronte Dr., Whittier, Calif.
ALMQUIST, J. O., Dept. of Dairy Husb., Pa. State Univ., State College
ALMY, E. F., 2632 Tremont Rd., Columbus, Ohio
ALONZO, JORGE, Ensenad 161 Luyano, Havana, Cuba
ALTER, J. R., 2246 Barrymore Ave., Columbus 19, Ohio
ALTON, A. J., Beatrice Foods, Beloit, Wis.
AMIDON, W. R., Route 4, Concord, N. H.
ANDERSON, E. O., Dept. of An. Ind., Univ. of Conn., Storrs
ANDERSON, G. C., State House, Boise, Idaho
ANDERSON, J. A., 901 S. Rogers, Springfield, Mo.
ANDERSON, J. J., Wood Ford Farm, Avon, Conn.
ANDERSON, OLIN, Consolidated Badger Coop., Shawano, Wis.
ANDERSON, R. J., Sisalkraft Co., 205 N. Wacker Dr., Chicago 6
ANDERSON, RAY, 1750 B Ave., N.E., Cedar Rapids, Iowa
ANDERSON, S. A., 765 Old Jonas Hill Rd., Lafayette, Calif.
ANDERSON, VIVIAN G., 1317 36th St., Sacramento, Calif.
ANDERSON, ZOE E., National Dairy Council, 111 N. Canal St., Chicago 6
ANDREWS, G. L., Breyer Ice Cream Co., Philadelphia, Pa.
ANGEVINE, N. C., Meyer-Blanke Co., 310 Russell Blvd., St. Louis 4, Mo.
ANTEL, R. K., Borden Co., Phoenix, Ariz.
ANTHONY, W. B., 231 Payne St., Auburn, Ala.
ARBUCKLE, W. S., Dairy Dept., Univ. of Md., College Park
ARCHIBALD, J. G., Dept. of An. Husb., Mass. State College, Amherst
AREY, J. A., Dept. of An. Ind., N. C. State College, Raleigh
ARMSTRONG, T. V., 2835 Norwood Ave., Columbus 11, Ohio
ARMSTRONG, W. H., Rocky Mount, Va.
ARNOLD, F. J., Dept. of An. Husb., Iowa State College, Ames
ARNOLD, P. T., Dept. of An. Husb., Univ. of Fla., Gainesville
ARRINGTON, L. R., Univ. of Fla., Gainesville
ASHWORTH, U. S., Dairy Dept., State College of Wash., Pullman
ASTROTH, F. B., 1453 Hythe St., St. Paul 8, Minn.
ATHERTON, R. P., Litchfield, Conn.
ATKESON, F. W., Dept. of Dairy Husb., Kans. State College, Manhattan
AURAND, L. W., Dept. of An. Ind., N. C. State College, Raleigh
AUSMAN, D. J., 212 Mill St., Horicon, Wis.
AUSTIN, C. J., Supplee-Wills-Jones Milk Co., Philadelphia 4, Pa.
AUTREY, K. M., Dept. of Dairy Husb., Ala. Polytechnic Inst., Auburn
AVAMPATO, JAMES, An. Diseases Dept., Univ. of Conn., Storrs

BABCOCK, C. J., 4500-48th St., N.W., Washington 16, D. C.
BABCOCK, WAYNE, 945 Berdan Ave., Toledo, Ohio
BABEL, F. J., Dairy Husb. Dept., Purdue Univ., Lafayette, Ind.
BAIRD, H. S., Golden State Co., 400 W. Carrillo St., Santa Barbara, Calif.
BAIRD, JUNIUS, Weber Central Dairy Cooperative, Ogden, Utah
BAISLER, W. R., 642 McClurg Rd., Youngstown 5, Ohio
BAKER, J. L., 20 Windley Ave., Toronto 20, Ont., Canada
BAKER, M. P., Dept. of Dairy Ind., Iowa State College, Ames
BAKER, R. J., Dairy Husb. Dept., S. D. State College, Brookings
BAKER, T. A., Dept. of An. & Poultry Ind., Univ. of Del., Newark
BALDWIN, C. S., 1683 Wyandotte Rd., Columbus, Ohio
BALDWIN, VERNON, New Prague, Minn.
BALL, K. L., 126 S. Comstock Ave., Whittier, Calif.
BALTZER, A. C., Dairy Dept., Mich. State College, East Lansing
BANKS, A. E., Box 156, Glendale, Ariz.
BARBER, F. W., National Dairy Research Labs., Oakdale, L. I., N. Y.
BARCO, C. K., Jr., 1135 N.W. 132nd St., Miami, Fla.
BARIBO, L. E., Western Condensing Co., Appleton, Wis.
BARKER, E. M., Rochester Dairy Coop., Rochester, Minn.
BARKMAN, J. O., Dept. of An. Ind., Univ. of Ky., Lexington
BARNES, J. C., Waconia, Minn.
BARNETT, B. F., Silver Lake, Ind.
BARNHART, J. J., Oaks, Pa.
BARNHILL, J. L., 608 E. Milwaukee Ave., Detroit 2, Mich.
BARON, MORRIS, 6606 S. Richmond St., Chicago
BARRETT, G. R., Chesterfield, N. H.
BARTER, F. J., 3638 N. Broadway, Chicago 13
BARTLE, EMERY, Dairy Dept., S. D. State College, College Station
BARTLE, ERVIN, 4517 Washburn Ave. S., Minneapolis, Minn.
BARTLETT, J. W., Dairy Dept., N. J. Agr. College, New Brunswick
BARTLETT, KATHRYN P., Route 5, Oshkosh, Wis.
BARTLEY, E. E., Dairy Dept., Kans. State College, Manhattan
BARTSCH, W. C., The Borden Co., 551 Waverly Ave., Brooklyn 38, N. Y.
BASSETT, H. J., Long View Rd., Rockaway, N. J.
BATEMAN, G. Q., Dept. of Dairy Husb. and Mfg., Utah State Agr. College, Logan
BAUERNFEIND, J. C., Hoffman-LaRoche Inc., Nutley 10, N. J.
BAUR, L. S., M & R Laboratories, 625 Cleveland Ave., Columbus, Ohio
BAYAR, MAX, P.O. Box 630, Alexandria, Va.
BAYER, A. H., General Ice Cream Corp., 101 Nott Terrace, Schenectady 1, N. Y.
BAYLEY, N. D., Dept. of Dairy Husb., Univ. of Minn., St. Paul 1
BEACH, F. L., 3521 Milwaukee Ave., Denver 5, Colo.
BEATY, ANNABEL, National Dairy Research Labs, Oakdale, L. I., N. Y.
BECHTEL, H. E., Box 68, North End Sta., Detroit 2, Mich.
BECK, G. H., Dairy Dept., Univ. of Md., College Park
BECK, H. H., 135 N. Main, Juneau, Wis.
BECK, L. D., Dept. of Dairy Husb., N. D. Agr. College, Fargo
BECK, NORMAN, Beck Vanilla Products Co., 650 S. San Vicente Blvd., Los Angeles 48, Calif.
BECKER, HENRY, Livingston Ave., Roseland, N. J.
BECKER, R. B., Dairy Dept., Univ. of Fla., Gainesville
BECKLEY, M. S., P. O. Bldg., San Jose 18, Calif.
BELANGER, GEORGES, Dept. of Agr., St. Hyacinthe, P. Q., Canada
BELL, L. S., Interlaken, N. Y.
BELL, R. W., 4409 Greenwich Pkwy., Washington 7, D. C.
BENDER, C. B., The Sperry Corp., 30 Rockefeller Plaza, New York 20
BENDIXEN, H. A., Dairy Husb. Dept., State College of Wash., Pullman
BENNETT, C. L., Matthews-Frechtling Dairy Co., 2363 St. James Ave., Cincinnati 6, Ohio
BENNETT, F. W., Dept. of Dairy Husb., Univ. of Ga., Athens
BENSON, K. L., Mass Farm Dairy, Chesterland, Ohio
BERG, E. K., Rio Grande, Ohio
BERGGREN, RUTH E. L., 274 Kings Highway E., Haddonfield, N. J.
BERLINER, V. R., Ortho Pharmaceutical Corp., Raritan, N. J.
BERNHART, F. W., Wyeth, Inc., Mason, Mich.
BEROUSEK, E. R., Dept. of Dairying, Oklahoma A & M College, Stillwater
BERRY, M. H., Carnation Milk Farms, Carnation, Wash.
BESEMER, A. M., 1340 St. Charles St., Alameda, Calif.
BESHEARS, W. G., Jr., Kraft Foods Co., Belt Line Rd., Garland, Texas
BIANCO, L. J., 2146 Illinois Rd., Northbrook, Ill.
BICHSEL, W. J., 139 2nd St. N.W., New Philadelphia, Ohio
BICKERS, J. R., 5144 Delmar Ave., St. Louis, Mo.
BIRD, E. W., Dept. of Dairy Ind., Iowa State College, Ames
BIRD, W. J., Nova Scotia Agr. College, Truro
BISHOP, J. V., Columbus, N. J.
BLACKMAN, C. L., Dairy Husb. Dept., Ohio State Univ., Columbus
BLALOCK, T. C., Dept. of An. Ind., N. C. State College, Raleigh
BLETCH, C. F., 1756 K St. N.W., Washington 6, D. C.
BLOCK, A. D., Badger Breeders Coop., Shawano, Wis.
BLOCK, R. J., 15 Cooper Rd., Scarsdale, N. Y.
BLOSSER, T. H., Dept. of Dairy Husb., Wash. State College, Pullman
BOARD, F. S., 1360 Lake Shore Drive, Chicago 10
BOBER, L. E., Babson Bros. Co., 2843 W. 10th St., Chicago
BOHMAN, V. R., An. Husb. Dept., Univ. of Nev., Reno
BOHSTEDT, GUSTAV, Dept. of An. Husb., Univ. of Wis., Madison
BONEWITZ, P. W., Bonewitz Chemicals Inc., Burlington, Iowa
BONEWITZ, RALPH, 1005 Ratone, Manhattan, Kans.
BOOK, J. H., Bureau of Dairy Industry, Beltsville, Md.

BOROWSKY, H. H., Onyx Oil & Chemical Co., Warren & Morris Sts., Jersey City, N. J.
BORTREE, A. L., Dept. of An. Husb., Pa. State Univ., State College
BOVING, S. G., The Borden Company, 3600 E. Forest, Detroit 7, Mich.
BOWER, K. W., Dept. of Dairy Husb., Univ. of Mo., Columbia
BOWLING, G. A., Strathglass Farm, Port Chester, N. Y.
BOYD, E. N., Dairy Dept., Univ. of Ky., Lexington
BOYD, L. J., Dept. of Dairy Sci., Univ. of Ill., Urbana
BOYLE, K. D., Calif. State Polytechnic College, San Luis Obispo
BOYNTON, HILTON, Dept. of Dairy Husb., Univ. of N. H., Durham
BRADFIELD, ALEC, Dept. of An. & Dairy Husb., Univ. of Vt., Burlington
BRADSHAW, C. W., 7379 Oregon Trail, Youngstown, Ohio
BRADT, C. G., An. Husb. Dept., Cornell Univ., Ithaca, N. Y.
BRADWAY, ELIZABETH M., 737 Maryland Ave., Syracuse 10, N. Y.
BRAEZEALE, D. F., Dairy Husb. Dept., S. D. State College, Brookings
BRAKEL, W. J., Dept. of Dairy Sci., Ohio State Univ., Columbus
BRANDT, G. W., Dairy Dept., Clemson Agr. College, Clemson, S. C.
BRANDT, P. M., Dept. of Dairy Husb., Ore. State Agr. College, Corvallis
BRANTON, CECIL, Dairy Dept., La. State Univ., Baton Rouge
BRATTON, EDWARD, Ronan, Mont.
BRATTON, R. W., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
BRATZLER, J. W., Dept. of An. Nutrition, Pa. State Univ., State College
BREMER, H. E., Dept. of Agr., State House, Montpelier, Vt.
BRENCE, J. L., Dairy Ind. Dept., Mont. State College, Bozeman
BRENES, LUIS RIVERA, Agr. Expt. Sta., Rio Piedros, P. R.
BRENNER, JAMES, Canadian Jersey Cattle Club, 290 Lawrence Ave. W., Toronto 12, Ont., Canada
BRERETON, J. G., Chemurgic Div., Sheffield Farms Co., Norwich, N. Y.
BRICKSON, W. L., 9401 E. 63rd St., Kansas City 30, Mo.
BRIGGS, S. E., 20 N. Wacker Dr., Chicago 6
BRISCOE, J. D., Silent Meadow Farm, Lakeville, Conn.
BROCK, O. C., 519-29 E. 18th St., Erie, Pa.
BROCKMEYER, G. H., 811 Green Lane, LaCanada, Calif.
BROCKSCHMIDT, J. H., 5198 Sidney Rd., Cincinnati 38, Ohio
BRODY, SAMUEL, Dairy Dept., Univ. of Mo., Columbia
BROUGHTON, C. L., Marietta, Ohio
BROWN, A. W., Brown's Velvet Dairy Products, 1332 Baronne St., New Orleans, La.
BROWN, C. A., 841 Exposition Blvd., New Orleans 15, La.
BROWN, D. C., An. Prod. Dept., Univ. of Wyo., Laramie
BROWN, L. J., 809 E. Walnut St., North Wales, Pa.
BROWN, R. E., 9602 49th Ave., College Park, Md.
BROWN, R. O., 726 W. Spring St., Appleton, Wis.
BROWN, R. W., Univ. of Manitoba, Winnipeg, Manitoba, Canada
BROWN, W. C., Kraft Foods Co., 923 Waukegan Rd., Glenview, Ill.
BROWNELL, S. J., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
BRUECKNER, H. J., 18 Manor Dr., Piedmont 11, Calif.
BRUNDAGE, A. L., Alaska Agr. Expt. Sta., Palmer
BRUNNER, J. R., Dairy Dept., Mich. State College, East Lansing
BRYAN, J. S., Walker-Gordon Laboratory Co., Plainsboro, N. J.
BRYAN, K. V., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
BRYAN, P. S., Route 1, Perkasie, Pa.
BRYAN, W. G., 78 Bluff Ave., LaGrange, Ill.
BRYANT, C. B. A., Montgomery, Mich.
BRYANT, H. W., 504 N. Willis St., Stockton, Ill.
BRYANT, J. H., Herbert St., St. Leonards, New South Wales, Aus.
BUCK, C. A., 2217 Clark St., Middleton, Wis.
BULKLEY, G. S., Carnation Co., Wilshire Labrea St., Los Angeles 36, Calif.
BUNDUS, R. H., 1119 Erie St., Oak Park, Ill.
BURGWALD, L. H., Dept. of Dairy Technol., Ohio State Univ., Columbus
BURKE, E. W., 76 Spruce St., Watertown, Mass.
BURKE, J. D., 1469 Slaterville Rd., Ithaca, N. Y.
BURKEY, L. A., Bureau of Dairy Industry, Beltsville, Md.
BURKEY, L. C., Creamery Package Mfg. Co., 500 Broadway, Toledo, Ohio
BURKITT, W. H., Colorado Milling & Elevator Co., 620 Equitable Bldg., Denver
BURLESON, R. E., Extension Service, College Station, Texas
BURNS, L. V., P. O. Box 439, Manhattan, Kans.
BURRELL, LOOMIS, Cherry-Burrell Corp., Little Falls, N. Y.
BURWELL, F. A., Armour Labs, Chicago
BUSCH, A. A., 2400 Park Blvd., Oakland 6, Calif.
BUSCHNER, F. A., 235 Cherry St., Shrewsbury, Mass.
BUSH, L. J., 104 Georgia St., Winchester, Ky.
BUSSEY, J. C., Christiansburg, Va.

CAINE, G. B., Dept. of Dairy Husb. and Mfg., Utah Agr. College, Logan
CAINE, RICHARD, Producers Creamery Co., Monett, Mo.
CAIRNS, G. M., Univ. of Md., College Park
CALBERT, H. E., Dept. of Dairy and Food Industries, Univ. of Wis., Madison
CALDWELL, W. R., Box 149, Oakdale, N. Y.
CALL, A. O., Western Condensing Co., Appleton, Wis.
CALLAWAY, F. E., Jr., Hills & Dales, LaGrange, Ga.
CAMIRAND, M. R., Hotel du Gouvernement, Quebec, P. Q., Canada
CAMPBELL, E. E., Beatrice Foods Co., 124 W. Wayne St., Lima, Ohio
CAMPBELL, F. M., Andalusia Dairy Co., Salem, Ohio
CAMPBELL, MASON, Univ. of R. I., Kingston
CAMPBELL, P. A., 535 19th Ave. N.E., St. Petersburg, Fla.
CANNON, C. Y., Foreign Agr. Relations, Beirut Lebanon, Dept. of State, Washington 25, D. C.
CANNON, R. Y., Dept. Dairy Husb., Ala. Polytechnic Inst., Auburn

CARDWELL, J. T., Dairy Dept., Miss. State College, State College
CARPENTER, BION, 1467 Slaterville Rd., Ithaca, N. Y.
CARPENTER, L. E., 1232 Enquirer Bldg., Cincinnati 2, Ohio
CARPENTER, M. C., Route 6, Louisville, Ky.
CARRANCEDO, EDUARDO G., Derivados de Leche S. A., Calle Del Alamo Num 40, Mexico D. F.
CARRINGER, H. N., Dept. of Dairying, Univ. of Tenn., Knoxville
CARTER, E. B., Meadow Gold Dairies, 304 S. Main St., Decatur, Ill.
CARTER, WILMOT, Wing Hall, Cornell University, Ithaca, N. Y.
CARVER, H. W., Carver Ice Cream Co., Oshkosh, Wis.
CASH, J. G., Dairy Sci. Dept., Univ. of Ill., Urbana
CASIDA, L. E., Dept. of Genetics, Univ. of Wis., Madison
CASKEY, C. D., Jr., Southern States Coop., 2101 E. Fort Ave., Baltimore 30, Md.
CASSIDY, B. J., 3110 Gillham Rd., Kansas City 9, Mo.
CATHCART, S. L., Iberia Exp. Farm, Jeanerette, La.
CAULFIELD, W. J., Dept. of Dairy Ind., Iowa State College, Ames
CAVANAUGH, J. F., American Jersey Cattle Club, 1521 E. Broad St., Columbus 5, Ohio
CHAFFEE, L. L., Morrisville, Vt.
CHAMBERLAYNE, E. C., Dept. of Health & Public Welfare, 320 Sherbrook St., Winnipeg, Manitoba, Canada
CHANCE, C. M., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
CHAPMAN, A. B., Dept. of Genetics, Univ. of Wis., Madison
CHAPMAN, G. A., Route 3, Piqua, Ohio
CHAPMAN, L. M., 293 White St., Danbury 7, Conn.
CHENG, E. W., Dept. of An. Husb., Iowa State College, Ames
CHILSON, W. H., Gen. Foods Corp., 11th & Hudson Sts., Hoboken, N. J.
CHOI, R. P., American Dry Milk Inst. Inc., 221 N. LaSalle St., Chicago 1
CHRISLER, E. S., The Borden Co., Milwaukee, Wis.
CHRISTENSEN, L. J., Dairy Coop. Assoc., 1313 S.E. 12th Ave., Portland 14, Ore.
CHRISTENSEN, SOREN, 2847 Stoddard St., San Bernardino, Calif.
CHRISTIANSEN, C. V., Bowman Dairy Co., 140 Ontario St., Chicago 10
CHRISTIANSEN, J. B., Box 1, Washta, Iowa
CHRYSLER, L. H., 2591 Brandon Rd., Columbus 21, Ohio
CHUMLEA, L. W., Associated Laboratories, 810 N. Meridian St., Lebanon, Ind.
CLAPP, E. E., Jr., New York State Agr. & Tech. Inst., Canton
CLARIN, D. X., Oakite Prods. Inc., 22 Thames St., New York 6
CLARK, R. B., 1497 Union Ave., Memphis, Tenn.
CLARK, R. D., Experimental Station, Lethbridge, Alberta, Canada
CLAXTON, A. J., Meadow Gold Dairies, 126 Dennistion Ave., Pittsburgh, Pa.
CLAYDON, T. J., Dairy Dept., Kans. State College, Manhattan
CLEMONS, H. B., 1409 W. 11th Place, Los Angeles 15, Calif.
CLEVELAND, G. W., 501 N. Kimball, Caldwell, Idaho
CLONINGER, W. H., An. Husb. Dept., Texas Technol. College, Lubbock
CLOUSE, S. H., 1418 Center Blvd., Springfield, Ohio
COARSEY, R. W., Riegeldale Farms, Trion, Ga.
COBB, S. M., Jr., New Middletown, Ohio
COBBLE, J. W., An. & Dairy Husb. Dept., Univ. of R. I., Kingston
COHEE, C. I., Dairy Council Inc., 234 S. 22nd St., Philadelphia 3, Pa.
COHEN, HAROLD, 28 Oakman St., Rochester 5, N. Y.
COHEN, ISAAC, 78-61 76th St., Brooklyn 27, N. Y.
COHENOUR, F. D., Armour Co., Sullivan, Ill.
COIE, R. T., Evergreen Breeders Assoc., Route 4, Chehalis, Wash.
COKER, S. P., Jr., Box 206, Hartsville, S. C.
COLE, H. H., Div. of An. Husb., Univ. of Calif., Davis
COLE, W. C., Arden Farms Co., 1900 W. Slauson Ave., Los Angeles, Calif.
COLEBANK, L. O., Agr. Extension Service, Univ. of Tenn., Knoxville
COLLIER, C. W., Indian Springs Farm, Darlington, Md.
COLLINS, E. B., Div. of Dairy Ind., Univ. of Calif., Davis
COLLINS, R. W., Weber Central Dairy Assoc., 1225 Wall Ave., Ogden, Utah
COLLINS, W. F., 91 Norwood, Park Forest, Ill.
COLLINS, W. J., Box 354, State College, Miss.
COLVARD, D. W., An. Ind. Dept., N. C. State College, Raleigh
COLVERT, R. W., Colvert Dairy Prod. Co., Ardmore, Okla.
COMBS, W. B., Dairy Div., Univ. of Minn., St. Paul
COMBS, WESLEY, Calif. State Polytechnic College, Pomona
CONE, J. F., Dept. of Bact., Pa. State Univ., State College
CONNELLY, H. M., 809 Stahlman Bldg., Nashville, Tenn.
CONNELLY, J. J., 307 Philadelphia St., Indiana, Pa.
CONNELLY, R. G., Dept. of Dairy Husb., Va. Polytechnic Inst., Blacksburg
CONNER, J. K., Lakeville Creamery Co., Lakeville, Minn.
CONRAD, H. R., Dept. of Dairy Sci., Ohio Agr. Expt. Sta., Wooster
CONVERSE, H. T., Amherst, N. H.
COPELAND, LYNN, Dept. of Dairying, Univ. of Tenn., Nashville
CORBETT, R. A., Dept. of An. Ind., Univ. of Maine, Orono
CORBETT, W. J., 1724 Ridge Ave., Rockford, Ill.
CORDES, W. A., Sealtest Inc., 260 Madison Ave., New York 16
CORDOVA, MARIO RAMOS, Berna 6, Esq. Paseo De La Reforma, Mexico 6, D. F.
CORLEY, E. L., Dept. of Dairy Husb., Univ. of Wis., Madison
CORRIE, C. K., 3559 Laguna Ave., Palo Alto, Calif.
CORY, W. M., 1104 W. 8th St., Santa Anna, Calif.
COULTER, S. T., Dept. of Dairy Husb., Univ. of Minn., St. Paul
COWAN, W. A., Dept. of An. Ind., Univ. of Conn., Storrs
COWLEY, P. F., Carlos Tercero 1117, Havana, Cuba
CRABTREE, G. H., Box 372, Abbottsford, B. C., Canada
CRAMER, A. J., 1642 Monroe St., Madison 5, Wis.
CRANDALL, W. T., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
CRANE, F. M., Land O'Lakes Creameries, 2215 Kennedy St. N.E., Minneapolis, Minn.
CROWE, L. K., Dairy Husb. Dept., Univ. of Neb., Lincoln

CROWLEY, J. W., Dairy Husb. Dept., Univ. of Wis., Madison
CUNNINGHAM, H. M., Chemistry Div., Sci. Service, Dept. of Agr., Ottawa, Canada
CURME, G. O., III, Route 2, Cochranville, Pa.
CURTIS, L. R., 2184 Oneida St., Salt Lake City 6, Utah

DAHLBERG, A. C., Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y.
DAHLBERG, A. O., 2500 W. Viewmont Way, Seattle 99, Wash.
DAHLE, C. D., Dept. of Dairy Husb., Pa. State Univ., State College
DAILY, H. J., 1000 N. University St., Peoria, Ill.
DANKENBRING, R. C., Farm Journal Inc., Washington Square, Philadelphia 5, Pa.
DARNELL, A. L., Dept. of Dairy Husb., Texas A & M College, College Station
DAVENPORT, F. N., Golden Glow Dairies Inc., Albany, Ga.
DAVEY, W. R., Dept. of Dairy Husb., Pa. State Univ., State College
DAVIS, A. V., N. La. Expt. Station, Calhoun
DAVIS, C. C., 2618 Calhoun St., New Orleans 18, La.
DAVIS, H. E., 103 S. 3rd St. W., Fort Atkinson, Wis.
DAVIS, J. G., 9 Gerrard St., London W. 1, England
DAVIS, LUKE, Kraft Foods Co., 248 Chester Ave. S.E., Atlanta, Ga.
DAVIS, M. E., Chiriqui Land Co., Puerto Armuelles, Panama, C. A.
DAVIS, R. F., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
DAVIS, R. N., Dairy Dept., Univ. of Ariz., Tucson
DAVISON, R. O., 31 Nassau St., New York 5
DAWDY, M. L., American Guernsey Cattle Club, 125 N. 4th St., Lafayette, Ind.
DAY, C. A., 520 Ash St., Ottawa, Kan.
DEAL, J. F., Mayfield Farms, Athens, Tenn.
DEANE, D. D., Dept. of Dairy Ind., Iowa State College, Ames
DECK, E. M., Mrs. Tucker's Foods, Sherman, Texas
DEHAVEN, GEORGE, 103 S. Hamel Rd., Los Angeles 48, Calif.
DE LACROIX, F. E., 1718 Northwestern Ave., W. Lafayette, Ind.
DELINGER, H. E., 809 Quimby Ave., Wooster, Ohio
DEL TORO, EMILIO, Jr., 611 Olimpo Ave., Santurce, P. R.
DE OLIVEIRA, WALDEMAR MIRANDA, Posto Zootecnico das Colonias, Montenegro, Rio Grande do Sul, Brazil
DERBER, D. W., 2831-525 William Penn Place, Pittsburgh 30, Pa.
DETWILER, B. H., 110 Hudson St., New York 13
DEUBLER, E. C., Newtown, Pa.
DEW, GEORGE, 8514 E. 47th St., Kansas City 29, Mo.
DIAMOND, W. T., American Feed Mfgrs. Assoc., 53 W. Jackson Blvd., Chicago
DICKERSON, G. E., Kimber Farms, Inc., Niles, Calif.
DICKEY, H. C., Dept. of An. Ind., Univ. of Maine, Orono
DICKSON, G. E., 73 W. Monroe, Chicago 3
DILLON, W. M., Dept. of Dairy Sci., Univ. of Ill., Urbana
DOAN, F. J., Dairy Dept., Pa. State Univ., State College
DODGE, H. E., 1244 Garfield, Topeka, Kans.
DOETSCH, R. N., Dept. of Bact., Univ. of Md., College Park
DONALDSON, H. K., 150- 5th St., Fond du Lac, Wis.
DONKER, J. D., Dairy Dept., Univ. of Ga., Athens
DORMUTH, L. C., Penn Salt Mfg. Co., 1000 Widener Bldg., Philadelphia 7, Pa.
DORSEY, L. M., Dairy Div., Univ. of Maine, Orono
DOSEGER, HENRY, Brantford Produce Co. Ltd., Brantford, Ont., Canada
DOUGHTY, R. S., 5 Lane of Acres, Haddonfield, N. J.
DOUGLAS, R. B., Beatrice Foods Co., New Bremen, Ohio
DOWD, L. R., Dept. of An. Ind., Univ. of Conn., Storrs
DOWNS, P. A., Dept. of Dairy Husb., Univ. of Neb., Lincoln
DOZIER, EMMITT, Jr., Plantation Foods Inc., 2957 Strickland St., Jacksonville, Fla.
DRACY, A. E., Dairy Husb. Dept., S. D. State College, Brookings
DRAGOO, E. T., 120 S. Benton, Palatine, Ill.
DRAIN, H. D., E. Park Drive, Hebron, Ohio
DRAKE, MAX, P. O. Box 1015, Tiffin, Ohio
DRAPER, H. H., Veterinary Research Dept., Merck & Co. Inc., Rahway, N. J.
DRAWBRIDGE, R. F., National Dairy Research Labs., Oakdale, L. I., N. Y.
DREHER, W. H., Badger Breeders Coop., Shawano, Wis.
DREYER, V. O., Borden's Finch Farm, 219 E. Fifth St., Dayton, Ohio
DREYER, W. A., 5929 College Ave., Oakland 18, Calif.
DRUMM, G. M., Calif. State Polytechnic College, San Luis Obispo
DUBIN, A. J., 15 E. 58th St., New York 22
DUBIN, THEODORE, 2800 Woodley Rd. N.W., Washington 8, D. C.
DUBRIC, WALTER, Inseminacion Artificial, Machiques Edo Zula, Venezuela, S. A.
DUGDALE, B. R., 4150 Hiawatha Dr., Madison, Wis.
DUNBAR, R. S., Jr., Dept. of Dairy Husb., W. Va. Univ., Morgantown
DUNCAN, C. W., Dept. of Agr. Chem., Mich. State College, East Lansing
DUNCAN, J. F., 1535 Plymouth, San Francisco 12, Calif.
DUNKLEY, W. L., Div. of Dairy Ind., Univ. of Calif., Davis
DUNN, H. O., 16 Sherman Terrace No. 6, Madison 4, Wis.

EASTIN, C. E., Bryan Station Rd., Lexington, Ky.
EATON, H. D., An. Ind. Dept., Univ. of Conn., Storrs
EATON, W. H., Dairy Dept., Ala. Polytechnic Inst., Auburn
ECKHOFF, GEORGE, Lakeville Creamery Co., Lakeville, Minn.
ECKLES, W. C., 328 E. 31st St., Kansas City, Mo.
EDMAN, G. A., Route 2, Robinson, Ill.
EDMONDSON, J. E., Dept. of Dairy Husb., Univ. of Mo., Columbia
EDWARDS, J. H., Insemikit Co. Inc., 426 Hitchcock St., Baraboo, Wis.
EISENSTEIN, NORMAN, 6159 N. Wolcott St., Chicago 26
ELDRED, R. E., A & P Tea Co., 211 Wacker Drive, Chicago 6

ELDRIDGE, FRANKLIN, Dept. of Dairy Husb., Kan. State College, Manhattan
ELLERTON, M. E., Carnation Co., 8015 Van Nuys Blvd., Van Nuys, Calif.
ELLICKSON, B. E., 231 Elm St., Glenview, Ill.
ELLIKER, P. R., Dept. of Bact., Ore. State College, Corvallis
ELLIOTT, F. I., American Breeders Service, Star Route, Asheville, N. C.
ELLIOTT, JAMES, Adohr Farms, Camarillo, Calif.
ELLIOTT, MURRAY, An. Husb. Dept., Univ. of Mass., Amherst
ELLIOTT, R. F., Lederle Labs, Pearl River, N. Y.
ELLIS, M. L. T., Star Route, Box 362, Kaneohe, Oahu, T. H.
ELLMORE, M. F., Dairy Ext., Va. Polytechnic Inst., Blacksburg
ELLSWORTH, P. R., American Dairy Science Assoc., Ohio State Univ., Columbus
ELMSLIE, W. P., Moorman Mfg. Co., Quincy, Ill.
ELY, FORDYCE, Dept. of Dairy Husb., Ohio State Univ., Columbus
ELY, R. E., Bureau of Dairy Industry, Beltsville, Md.
EMERY, R. S., Dairy Dept., Mich. State College, East Lansing
ENGLAND, C. W., 4408 Undersood St., Hyattsville, Md.
ENGLE, B. Q., 6418 California St., San Francisco 21, Calif.
ENGRAM, L. W., Dairy Dept., Prairie View A & M College, Prairie View, Texas
ERB, R. E., Dept. of Dairy Husb., State College of Wash., Pullman
ERB, J. H., 1697 Berkshire Rd., Columbus 12, Ohio
ERCH, A. G., Artificial Breeding Corp., Lewisburg, Pa.
EREKSON, A. B., Lakeshire-Marty Co., Plymouth, Wis.
ERWAY, JOHN, Ordnance Ammunition Center, Joliet, Ill.
ESHELMAN, R. H., Dr. Hess & Clark Inc., Ashland, Ohio
ESKIN, MARVIN, 1023 Quebec Terrace, Silver Spring, Md.
ESPE, D. L., Office of Experiment Stations, USDA, Washington 25, D. C.
EVERETT, ROBERTS, 1108 16th St., N.W., Washington 6, D. C.
EWALT, H. P., Dept. of Dairy Husb., Ore. State College, Corvallis
EWBANK, F. C., Mich. Milk Producers Assoc., Imlay City, Mich.
EWING, M. B., Dept. of Dairy Husb., Kan. State College, Manhattan

FABRICIUS, N. E., Ladysmith Milk Producers Coop. Assoc., Ladysmith, Wis.
FAGEN, H. J., 1699 Elmwood Drive, Highland Park, Ill.
FAIRBANKS, B. W., American Dry Milk Inst., 221 N. LaSalle St., Chicago
FAIRCHILD, F. C., Prairie Farms Creameries, 219 W. Monroe St., Bloomington, Ill.
FALCONER, D. B., 3333 Grand River Ave., Detroit 32, Mich.
FARNHAM, M. G., Route 4, Waukesha, Wis.
FARRALL, A. W., Dept. of Agr. Eng., Mich. State College, East Lansing
FARRAR, R. R., Route 8, St. Paul 10, Minn.
FASSETT, W. W., 3949 E. Pacific Ave., Sacramento, Calif.
FAY, A. C., H. P. Hood & Sons, 500 Rutherford Ave., Boston, Mass.
FECHHEIMER, N. S., Dairy Sci. Dept., Ohio State Univ., Columbus
FENNER, G. H., Western Dairy & Ice Cream Co., 218 S. 5th St., St. Joseph, Mo.
FENTON, F. E., Box 133, Spokane 10, Wash.
FERRAEZ, NICOLAS, 5800 Pershing Ave., St. Louis 12, Mo.
FEUTZ, FRED, Lakeshire Marty Co., Monroe, Wis.
FIFER, RUSSELL, American Butter Inst., 110 N. Franklin St., Chicago 6
FIKE, J. E., Dairy Dept., W. Va. Univ., Morgantown
FINCHAM, R. C., Dept. of An. Husb., Iowa State College, Ames
FINNEGAN, E. J., Dept. of Dairy Husb., Va. Polytechnic Inst., Blacksburg
FISHMAN, R. H., Standard Brands Inc., 595 Madison Ave., New York 22
FITCH, F. W., Dept. of Dairy Husb., Univ. of Ga., Athens
FITCH, J. B., Dept. of Dairy Husb., Univ. of Minn., St. Paul
FITZMAURICE, D. T., Cherry-Burrell Corp., Little Falls, N. Y.
FITZSIMMONS, ROBERT, 25 Jones Ave., New Brunswick, N. J.
FLAKE, J. C., 325 Callan, Evanston, Ill.
FLEMING, W. C., Bayville Farms, Box 2491, Norfolk 1, Va.
FLETCHER, LANE, College Station, Texas
FLIPSE, R. J., Dept. of Dairy Husb., Pa. State Univ., State College
FOGG, E. C., 101 Alton Rd., Miami Beach 39, Fla.
FOHRMAN, M. H., Bureau of Dairy Industry, Beltsville, Md.
FOLEY, DAN, P. O. Box 1391, Vallejo, Calif.
FOLEY, R. C., Dept. of An. Husb., Univ. of Mass., Amherst
FOLKERS, E. C., Meadow Gold Dairies, Pittsburgh, Pa.
FONALLEDOS, J., Box 397, Hato Rey, Puerto Rico
FOOTE, R. H., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
FORBES, B. F., Brecksville, Ohio
FORD, T. F., 3071 W. Woodrow St., Arlington, Va.
FOREMAN, C. F., Dept. of Dairy Husb., Univ. of Minn., St. Paul
FORSTER, T. L., Dept. of Dairy Husb., N. D. Agr. College, Fargo
FOSSLAND, R. G., Dairy Husb. Dept., Univ. of Neb., Lincoln
FOSTER, E. M., Dept. of Bact., Univ. of Wis., Madison
FOSTER, H. G., Jr., Poe Ave., Homewood, Ill.
FOSTER, J. R., 241 N. Figueroa, Los Angeles 12, Calif.
FOSTER, J. W., Dairy Dept., Univ. of Ky., Lexington
FOUNTAINE, F. C., Dept. of Dairy Husb., Kan. State College, Manhattan
FOURNELLE, H. J., U. S. Public Health Service, Anchorage, Alaska
FOURT, D. L., Dept. of Dairy Husb., Univ. of Idaho, Moscow
FOUTS, E. L., Dept. of Dairy Sci., Univ. of Fla., Gainesville
FOX, W. K., 918 Hickory St., Waukegan, Ill.
FRAM, HARVEY, Natl. Dairy Research Labs., Oakdale, L. I., N. Y.

FRANCIS, JULIUS, The Borden Co., Phoenix, Ariz.
FRANCISCO, CARL, 2035 Cinderella Rd., Springfield, Mo.
FRANKLIN, N. L., Div. of Dairy and Foods, 1003 State Office Bldg., Richmond, Va.
FRASURE, R. E., 337 North St., Logan, Ohio
FRAYER, J. M., Dept. of An. & Dairy Husb., Vt. Agr. Expt. Sta., Burlington
FRAZIER, W. C., Dept. of Bact., Univ. of Wis., Madison
FREDRIKSEN, F. M., 222 Third St. N.E., Faribault, Minn.
FREEDMAN, MICHAEL, 781 Dotame St., Apple Valley, Calif.
FREEMAN, S. L., 419 Spring St., W. Bridgewater, Mass.
FREEMAN, T. R., Dept. of An. Ind., Univ. of Ky., Lexington
FREIDEL, E. H., Arden Farms Co., Patterson, Calif.
FREY, E. W., Superior Ice Cream Co., Douglas, Ga.
FRIEDMAN, AARON, 327 Central Park West, New York 25
FRITZ, J. C., 156 Villa St., Elgin, Ill.
FROEDGE, J. R., Fort Worth Poultry & Egg Co. Inc., Fort Worth, Texas
FROHRING, P. R., Chagrin Falls, Ohio
FROST, R. E., American Dairy Association, 20 Wacker Dr., Chicago 6
FRYE, J. B., Jr., Dairy Dept., La. State Univ., Baton Rouge
FRYMAN, L. R., Dept. of Dairy Sci., Univ. of Ill., Urbana

GAALAAS, R. F., U. S. Dairy Station, Mandan, N. D.
GALEMA, M. L., Route 1, Lafayette, Ind.
GALL, LORRAINE S., Natl. Dairy Research Lab., Oakdale, L. I., N. Y.
GALLAMORE, WILLIAM, Arcade G.L.F., Arcade, N. Y.
GALLAMORE, WILLIAM, Feura Bush, N. Y.
GALLIKER, LOUIS, Galliker Ice Cream Co., 453 Franklin St., Johnstown, Pa.
GALVIN, F. J., 12 Holly Ave., Cambridge 38, Mass.
GAMBLE, J. H., Pasteurezadora de Haladoes, Club S. A. Carle Reale 110, Caracas, Venezuela
GANNON, E. A., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
GANTT, P. A., Rosedale, La.
GARDNER, K. E., Dept. of Dairy Sci., Univ. of Ill., Urbana
GARRECHT, HUBERT, Klinke Bros. Dairy, 2469 Summer Ave., Memphis, Tenn.
GARRETT, O. F., M & R Dietetic Labs. Inc., 625 Cleveland Ave., Columbus 16, Ohio
GARRISON, E. R., Dept. of An. Ind., Univ. of Ark., Fayetteville
GASSNER, F. X., Dept. of Chem., Colo. A & M College, Ft. Collins
GAUMNITZ, E. W., 110 N. Franklin St., Chicago 6
GAUNT, S. N., Dairy Ind. Dept., Univ. of Mass., Amherst
GAUNYA, W. S., Dept. of An. Ind., Univ. of Conn., Storrs
GAVIN, J. S., Gavin Dairy Lab., 200 Stockbridge, Buffalo 15, N. Y.
GAYMONT, STEPHEN, 315 N. Clark St., Chicago 10
GEARHART, C. R., Dept. of Dairy Husb., Pa. State Univ., State College
GEBHARDT, H. T., 324 W. 6th St., Marysville, Ohio
GEE, GASTON, Buckfield Plantation, Yemassee, S. C.
GEENTY, W. T., Jr., 25 Lenox Ave., Providence, R. I.
GEHRKE, C. W., Dept. of Agr. Chem., Univ. of Mo., Columbia
GEIGER, ROBERT, 2274 W. Como Ave., St. Paul 8, Minn.
GELBMAN, MILTON, 1332 Monticello Rd., Jacksonville, Fla.
GELPI, A. J., Jr., Dept. of Dairying, La. State Univ., Baton Rouge
GEMMILL, A. V., Food Engineering, 330 W. 42nd St., New York 36
GEORGE, B. J., Kansas City Power & Light Co., 1330 Baltimore Ave., Kansas City 41, Mo.
GEORGE, J. D., Dept. of An. Ind., N. C. State College, Raleigh
GEORGE, J. S., Tillamook Co. Creamery Assoc., Tillamook, Ore.
GEYER, F. E., 525 Bridle Rd., Glenside, Pa.
GHOLSON, J. H., Dept. of Dairy Husb., Univ. of Mo., Columbia
GIBERSON, E. M., Lidford Road at Pioneer Way, Puyallup, Wash.
GIBSON, A. L., Kemptville Agr. School, Kemptville, Ontario, Canada
GIBSON, C. A., Central Expt. Farm, Ottawa, Ont., Canada
GIFFORD, WARREN, Dept. of An. Ind., Univ. of Ark., Fayetteville
GILLESPIE, DALE, 1243 W. Washington Blvd., Chicago 7
GILMORE, H. C., Dept. of Dairy Husb., Pa. State Univ., State College
GILMORE, JOHN, New York Artificial Breeders Coop., Ithaca, N. Y.
GILMORE, L. N., Maritime Milling Co., 1009 Chamber of Commerce Bldg., Buffalo, N. Y.
GILMORE, L. O., Dept. of Dairy Sci., Ohio Agr. Expt. Sta., Wooster
GINGERY, ROY, 2120 Richland Ave., Lakewood 7, Ohio
GLASS, N. R., 325 Clearfield Ave., Trenton, N. J.
GLASS, R. D., 585½ Allen Ave., Chillicothe, Ohio
GLEASON, R. R., 159 Pleasant St., Arlington 74, Mass.
GOHEEN, R. L., Box 169, Lynden, Wash.
GOLD, HERMAN, 470 E. 33rd St., Paterson 4, N. J.
GOLD, T. S., Cream Hill Farm, West Cornwall, Conn.
GOLDFRANK, H. J., Stein Hall & Co., 285 Madison Ave., New York
GOLDING, N. S., Dairy Husb. Dept., Wash. State College, Pullman
GOODALE, B. E., Clemson Agr. College, Clemson, S. C.
GOODBARY, W. A., American Embassy, APO 206-A, c/o Postmaster, New York, N. Y.
GOODMAN, M. C., Jr., Goodman American Corp., Federal at 45th St., Chicago 9
GOODWIN, MARY M., 603 Campus Ave., Pullman, Wash.
GORANSON, R. F., 1304 E. 7th St., Los Angeles 21, Calif.
GORDON, G. E., Dairy Ext. Service, Univ. of Calif., Berkeley
GOSS, E. F., Dept. of Dairy Ind., Iowa State College, Ames
GOSSER, HAROLD, 409 Warrington Ave., Pittsburgh, Pa.
GOULD, G. B., Alto Cooperative Creamery, Waupun, Wis.
GOULD, I. A., Dairy Technol. Dept., Ohio State Univ., Columbus

GOWER, C. J., 126 Jewel, Longview, Texas
GRAF, G. C., Dairy Dept., Va. Polytechnic Inst., Blacksburg
GRAHAM, M. D., Roberts Dairy Co., 4469 Farnam St., Omaha, Neb.
GRAHAM, W. R., Jr., The Quaker Oats Co., Chicago 16
GRANDISON, E. G., Swift & Co., Union Stock Yards, Chicago
GRANT, F. M., Bureau of Dairy Industry, Washington 25, D. C.
GRAVES, R. R., Glen Farm, Germantown, Md.
GRAY, F. M., Southern Dairies Inc., 60 M St. N.E., Washington, D. C.
GREEN, D. F., Allied Chemical & Dye, 40 Rector St., New York 6
GREENBANK, G. R., 632 24th St. S, Arlington, Va.
GREENLEAF, F. M., 1724 Congress St., Allentown, Pa.
GREER, D. M., Route 1, River Road, Naperville, Ill.
GREGORY, H. W., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
GREINER, F. J., Ohio Dairy Products Assoc., 5 E. Long St., Columbus 15, Ohio
GREZE, J. P., Oakite Prod., Inc., 22 Thames St., New York 6
GRIMES, M., Dairy Bact. Dept., University College, Cork, Ireland
GROSS, J. R., 116 Orange Ave., Cranford, N. J.
GROSSMITH, F. J., Jr., R. F. D. 376, Foxboro, Mass.
GROW, WALTER, Clover Leaf Dairy Co., 265 Beech St., Pottstown, Pa.
GUERRANT, N. B., Dept. of Chem., Pa. State Univ., State College
GULLICKSON, T. W., Dept. of Dairy Husb., Univ. of Minn., St. Paul
GUNTHARDT, HANS, 1800 C St., Pullman, Wash.
GUTHRIE, R. S., 812 N. 4th St., DeKalb, Ill.
GUY, E. J., Dept. of Agr. Biochem., Univ. of Minn., St. Paul
GWYNETTE, GRESWOLD, 44 Bee St., Charleston 39, S. C.

HAAG, J. R., Dept. of Chem., Ore. State College, Corvallis
HADFIELD, W. A., Penn Salt Mfg. Co., 1000 Widener Bldg., Philadelphia 7, Pa.
HAGBERG, E. C., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
HAINES, C. E., 5422 Riverdale Rd., Riverdale, Md.
HALE, L. G., Apartado 593, Panama, Republic de Panama
HALES, M. W., Chr. Hansen's Lab. Inc., 9015 W. Maple St., Milwaukee 14, Wis.
HALL, C. N., Dept. of Dairy Husb., Pa. State Univ., State College
HALLER, H. S., 4120 Everett St., Kensington, Md.
HALLETT, RAY, Sodus Creamery Corp., Wolcott, N. Y.
HALMBACHER, PAUL, Paul-Lewis Laboratories Inc., 4253 N. Port Washington Rd., Milwaukee 12, Wis.
HAMAN, R. W., The Wander Co., Villa Park, Ill.
HAMILTON, G. B., Inter Minerals & Chem. Co., 20 N. Wacker Dr., Chicago 6
HAMILTON, T. K., Diamond Milk Prods., Inc., 315 Graham St., Columbus 3, Ohio
HAMMOND, P. W., 2030 Harford Rd., Baltimore, Md.
HAMOR, W. A., Mellon Inst., 4400 Fifth Ave., Pittsburgh 13, Pa.
HANKINSON, C. L., Route 2, Paynesville, Minn.
HANKINSON, D. J., Dept. of Dairy Ind., Univ. of Mass., Amherst
HANSARD, S. L., Univ. of Tenn., A.E.C., Oak Ridge, Tenn.
HANSEL, WILLIAM, Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
HANSEN, E. N., Curtiss Candy Co., Cary, Ill.
HANSEN, H. C., Dept. of Dairy Husb., Univ. of Idaho, Moscow
HANSEN, H. M., Dept. of An. Ind., Univ. of Conn., Storrs
HANSEN, R. G., Dept. of Dairy Sci., Univ. of Ill., Urbana
HANSEN, VERNON, Crystal Cream & Butter Co., Sacramento 6, Calif.
HANSON, C. C., Barnum Creamery Co., Barnum, Minn.
HANSON, DICK, Meredith Publishing Co., Des Moines 3, Iowa
HANSON, R. L., Lindstrom, Minn.
HAQ, MD. OBAYEDUL, East Bangal Vet. College, P. O. Tejgaon, Dacca, Pakistan
HARDELL, ROBERT, 2020 10th St., Monroe, Wis.
HARDING, H. G., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
HARE, J. H., Pabst Laboratories, 1037 W. McKinley Ave., Milwaukee 3, Wis.
HARLAND, F. G., Dept. of Dairy Husb., A & M College of Texas, College Station
HARLAND, H. A., Div. of Dairy Husb., Univ. of Minn., St. Paul
HARMAN, T. D., 325 S. Court St., Circleville, Ohio
HARMON, E. M., U. S. Operations Mission, Teheran, Iran, A.P.O. 205, c/o Postmaster, New York
HARMON, L. G., Dept. Dairy Mnfrs., Texas Tech. College, Lubbock
HARPER, CLAUDE, Jr., Beatrice Foods Co., 1526 S. State St., Chicago 5
HARPER, R. T., Roanoke City Mills Inc., Roanoke, Va.
HARPER, W. J., Dept. of Dairy Technol., Ohio State Univ., Columbus
HARRISBERGER, W. E., P. O. Box 92, Helena, Mont.
HARRISON, T. B., Dept. of Dairying, Univ. of Tenn., Knoxville
HARSHBARGER, K. E., Dept. of Dairy Sci., Univ. of Ill., Urbana
HARTLEY, C. B., 205 S. Bench St., Galena, Ill.
HARTMAN, A. M., Bureau of Dairy Industry, Beltsville, Md.
HARTMAN, G. H., White House Milk Co., Manitowoc, Wis.
HARVEY, J. E., Jr., 716 E. Woodside St., South Bend, Ind.
HARVEY, W. R., Dept. of Dairy Husb., Univ. of Idaho, Moscow
HASKELL, W. H., Klenzade Products, Inc., Beloit, Wis.
HATFIELD, R. C., 2756 E. Grand River Ave., East Lansing, Mich.
HATHAWAY, I. L., Dept. of Dairy Husb., Univ. of Neb., Lincoln
HATHORN, FRED, Box 87, S.L.I. Station, Lafayette, La.
HATLER, F. J., 187 Cal, Tiffin, Ohio
HATZIOLOS, B. C., Livestock Sanitary Service Lab., Univ. of Md., College Park
HAWKINS, E. E., Good Humor Co., 999 W. Washington Blvd., Los Angeles, Calif.
HAWKINS, G. E., Box 83, Greenwood, S. C.
HAWKINS, G. E., Jr., Dairy Husb. Dept., Ala. Polytechnic Inst., Auburn

HAWKINS, J. K., 314 Main St., LaGrange, Ga.
HAWKINS, O. J., 2274 Como Ave., St. Paul 8, Minn.
HAWKINS, V. M., Jr., Benson, Vt.
HAYS, J. C., 605 Butterfield Dr., E. Lansing, Mich.
HAYS, R. L., Dept. of Dairy Sci., Univ. of Ill., Urbana
HAZLEWOOD, B. P., P. O. Box 1549, Jackson, Tenn.
HEAD, T. P., Progressive Farmer, 303 Cotton Exchange Bldg., Memphis 3, Tenn.
HEALY, H. A., Dairy Products Labs., 2244 Carter Ave., St. Paul 8, Minn.
HEDRICK, T. I., 626 S. Maple Ave., Oak Park, Ill.
HEEBINK, GERALD, Dept. of Dairy Husb., Univ. of W. Va., Morgantown.
HEIMAN, VICTOR, Kasco Mills Inc., Waverly, N. Y.
HEINEMAN, BURDET, Producers Creamery Co., Springfield, Mo.
HEISKELL, H. Y., 1014 Grand Ave., Phoenix, Ariz.
HEIZER, E. E., Dairy Husb. Dept., Univ. of Wis., Madison
HELLAMS, J. I., Greenwood Creamery Co., Greenwood, S. C.
HELLER, PAUL, Orchard Rd., Woodbridge 15, Conn.
HEMB, D. M., 3659 Harrison St., Chicago 24
HENDERSEN, H. O., Dept. of Dairy Husb., W. Va. Univ., Morgantown
HENDERSON, C. R., An. Husb. Dept., Cornell Univ., Ithaca, N. Y.
HENDERSON, H. B., Dairy Dept., Univ. of Georgia, Athens
HENDERSON, J. L., Golden State Co., Ltd., 425 Battery St., San Francisco, Calif.
HENDRICKSON, F. A., Tri-State Breeders Coop., Westby, Wis.
HENING, J. C., Dept. of Food Sci. & Technol., N. Y. State Agr. Expt. Sta., Geneva
HENKE, J. R., Sidney Dairy Products Inc., 507 N. Miami Ave., Sidney, Ohio
HENKE, L. A., Agr. Expt. Sta., Univ. of Hawaii, Honolulu
HENRY, CAMERON, Farm Journal, Geneva, Ill.
HENRY, J. W., The Borden Co., 350 Madison Ave., New York 17
HERMAN, H. A., Natl. Assoc. Artificial Breeders, Exchange Natl. Bank Bldg., Columbia, Mo.
HERREID, E. O., Dept. of Food Technol., Univ. of Ill., Urbana
HERRINGTON, B. L., Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y.
HERRMANN, L. F., 3022 N. Westmoreland Dr., Falls Church, Va.
HERRO, A. C., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
HERZER, F. H., Dept. of Dairying, Miss. State College, State College
HESSEL, F. H., Coop. G.L.F., Box 973, Buffalo 5, N. Y.
HESSELTINE, W. R., Agr. Ext. Service, Univ. of Conn., Storrs
HETRICK, J. H., Dean Milk Co., 1126 Kilburn Ave., Rockford, Ill.
HEUBSCH, HAROLD, 3615 Jewell, San Diego 9, Calif.
HIBBEN, R. C., Intern. Assoc. of Ice Cream Mfgrs., 1105 Barr Bldg., Washington 6, D. C.
HIBBS, J. W., Dept. of Dairy Sci., Ohio Agr. Expt. Sta., Wooster
HIBBS, R. A., 514 E. 10th Ave., Spokane, Wash.
HIDINGER, ORVIS, 100 Chamber of Commerce Bldg., Scranton 3, Pa.
HIGGINS, L. A., Starkville, Miss.
HIGLEY, P. I., American Breeders Service, 325 N. Wells St., Chicago 10
HILEMAN, J. L., Dairymen's League, 810 Burnett, Syracuse 3, N. Y.
HILFIKER, H. G., Box 487, Boise, Idaho
HILKER, L. D., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
HILL, D. L., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
HILL, H. J., Vet. Hosp., Colo. A & M College, Ft. Collins
HILL, O. J., Washington Coop. Egg & Poultry Assoc., 201 Elliott Ave. W., Seattle 99, Wash.
HILL, W. B., Box 7, Palmyra, Wis.
HINTON, S. A., Dept. of Dairying, Univ. of Tenn., Knoxville
HIXSON, E. L., Pet Milk Co., Mayfield, Ky.
HOBACK, J. D., Armour & Co., Sullivan, Ill.
HOBSON, CURTIS, Marlu Farm, Lincroft, N. J.
HOBSON, W. M., Foremost Dairies, Spartansburg, S. C.
HOCHBERG, M., Nopco Chemical Co., Harrison, N. J.
HODGSON, R. E., Bureau of Dairy Ind., Washington 25, D. C.
HODGSON, SCOTT, Western Washington Expt. Sta., Puyallup
HOECKER, W. H., Richeport, Mo.
HOFFMAN, GLENN, 4607 Fordham Rd., College Park, Md.
HOGAN, R. J., 5913 Hickam Drive, Dayton 3, Ohio
HOLDAWAY, C. W., Dept. of Dairy Husb., Va. Polytechnic Inst., Blacksburg
HOLLAND, R. F., Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y.
HOLLENDER, H. A., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
HOLM, G. E., Bureau of Dairy Industry, Washington, D. C.
HOLM, W. K., 623 Board of Trade Bldg., Indianapolis, Ind.
HOLMAN, C. W., 1731 Eye St. N.W., Washington 6, D. C.
HOLMES, A. D., Dept. of Chem., Univ. of Mass., Amherst
HOLMES, C. L., Box 22, Battle Ground, Wash.
HOMBERGER, R. E., P.O. Box 402, West Sayville, N. Y.
HOMEYER, W. C., 2127 Bolsover, Houston 5, Texas
HONER, C. J., Ramsey Labs., Lisbon Rd. & Evins Ave., Cleveland, Ohio
HOOPES, L. N., Lucerne Milk Co., 1717 E. Colfax, Denver, Colo.
HOOVER, S. R., Eastern Regional Research Lab., Philadelphia 18, Pa.
HOPE, E. B., Northwest Coop Breeders, Mt. Vernon, Wash.
HOPSON, G. H., South Rd., Millbrook, N. Y.
HORN, D. W., Box 666, Bryn Mawr, Pa.
HORRALL, B. E., 6759 S. Oglesby Ave., Chicago 49
HORWOOD, R. E., Upper Peninsula Expt. Sta., Chatham, Mich.
HOSTETLER, P. H., Harper Creamery, Harper, Kan.
HOWARD, H. A., 750 N. Pleasant St., Amherst, Mass.
HOWARD, H. W., 350 Madison Ave., New York 17
HOWE, J. W., Miller School, Va.
HOWELL, H. B., J. J. Astor Expt. Sta., Astoria, Ore.
HOYNAK, P. X., Refined Syrups & Sugars, Inc., Yonkers, N. Y.
HOYT, R. M., 1206 W. Clark, Champaign, Ill.
HUBBELL, BRUCE, Jr., 1102 B St., Davis, Calif.
HUFFER, E. G., 1328 Noble Ave., Springfield, Ill.

HUFFMAN, C. F., Dairy Dept., Mich. Agr. College, East Lansing
HUGHES, C. E., Armour and Co., Union Stock Yards, Chicago 9
HULL, M. E., 330 S. Catherine Ave., LaGrange, Ill.
HUNNICUTT, W. D., Natl. Dairy Products Corp., 260 Madison Ave., New York 16
HUNSAKER, L. R., 46 N. 4th West, Logan, Utah
HUNT, L. L., Pet Milk Co., 1411 Arcade Bldg., St. Louis 1, Mo.
HUNT, R. W., Academy St., Bayport, N. Y.
HUNTINGTON, C. L., The Borden Co., 34 Queen's Road, Melbourne, C. 1, Aus.
HURLEY, W. C., Dept. of An. Husb., Tenn. Agr. & Ind. Univ., Nashville
HURST, VICTOR, Dairy Dept., Clemson Agr. College, Clemson, S. C.
HURTADO, MARIO L., Apartado No. 2249, Sancti-Spiritus, L. V., Cuba
HUSSONG, R. V., Kraft Foods Co., 923 Waukegan Rd., Glenview, Ill.
HUSTON, K. A., Dept. of Dairy Husb., Va. Polytechnic Inst., Blacksburg
HUTCHINSON, H. F., P. O. Box 351, Lewisburg, W. Va.
HUTTON, C. A., Dept. of Dairying, Univ. of Tenn., Knoxville
HYATT, GEORGE, Jr., Dept. of An. Ind., N. C. State College, Raleigh

IACONO, P. P., 52 Francis St., Iselin, N. J.
IDDINGS, H. G., 4836 E. Marquette Rd., East Gary, Ind.
IDTSE, FRED, 800 Pleasant St., Beloit, Wis.
INGLE, J. D., 9825 S. Peoria St., Chicago
INOUYE, KENJI, 97 Miyuki-cho, Shizunai-machi, Hidaka-no-kuni, Hokkaido, Japan
IRMITER, T. F., Chr. Hansen's Lab., Little Falls, N. Y.
IRVIN, H. M., Greenbelt, Md.
IRVINE, O. R., Ont. Agr. College, Guelph, Ont., Canada
ITSCHNER, E. T., Dept. of Dairy Husb., Univ. of Mo., Columbia
IVERSON, C. A., Dept. of Dairying, Iowa State College, Ames

JACK, E. L., Div. of Dairy Ind., Univ. of Calif., Davis
JACKSON, H. C., Dept. of Dairy & Food Ind., Univ. of Wis., Madison
JACOBSEN, D. H., Cherry-Burrell Corp., 427 W. Randolph St., Chicago
JACOBSON, N. L., Dept. of An. Husb., Iowa State College, Ames
JACOBSON, W. C., Bureau of Dairy Industry, Washington, D. C.
JAGGARD, GEO., 2300 Locust St., Philadelphia 3, Pa.
JAMISON, O. A., 227 Devonshire Dr., San Antonio 9, Texas
JANDER, J. C., 413 S. Harding St., Enid, Okla.
JANZEN, J. J., Continental Can Co., 4645 W. Grand Ave., Chicago 39
JARDINE, R. H., 409 Huron St., Toronto 5, Canada
JARVIS, R. N., Southern States Coop., 2101 E. Fort Ave., Baltimore 30, Md.
JENNESS, ROBERT, Div. of Agr. Biochem., Univ. of Minn., St. Paul
JENNINGS, L. L., Box 457 A, Blooming Prairie, Minn.
JENSEN, CHRIS, Dairy Husb. Dept., N. D. Agr. College, Fargo
JENSEN, J. M., Dairy Dept., Mich. State College, E. Lansing
JEWELL, R. M., 1103 E. Vine St., Mt. Vernon, Ohio
JEZESKI, J. J., Dept. of Dairy Husb., Univ. of Minn., St. Paul
JINDRA, A. C., Court House, Portage, Wis.
JOHNSON, A. H., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
JOHNSON, B. CONNOR, Dept. of An. Sci., Univ. of Ill., Urbana
JOHNSON, BRUCE C., 5851 N. High St., Apt. B, Worthington, Ohio
JOHNSON, C. R., The Baker Laboratories, East Troy, Wis.
JOHNSON, GERALD, 2105 Garfield St., Eugene, Ore.
JOHNSON, H. L., 2442 S. Elm Ave., Fresno 6, Calif.
JOHNSON, J. B., A M & N College, Pine Bluff, Ark.
JOHNSON, K. R., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
JOHNSON, L. A., Dairy Dept., Mich. State College, East Lansing
JOHNSON, L. E., Dept. of Vet. Med., Univ. of Neb., Lincoln
JOHNSON, L. W., Whitmoyer Labs Inc., Myerstown, Pa.
JOHNSON, M. W., 103 E. York St., Ithaca, N. Y.
JOHNSON, P. R., Dept. of Dairying, Okla. A & M College, Stillwater
JOHNSON, R. E., Dept. of An. Ind., Univ. of Conn., Storrs
JOHNSON, T. V., 21641 Shillingsburg Ave., Los Gatos, Calif.
JOHNSTON, FLOYD, American Jersey Cattle Club, 1521 E. Broad St., Columbus 5, Ohio
JOHNSTON, J. B., 4236 Lovell Ave., Fort Worth 7, Texas
JOHNSTON, J. E., Dairy Dept., La. State Univ., Baton Rouge
JOHNSTON, W. L., Westerville Creamery Co., Westerville, Ohio
JONES, F. L., The Borden Co., 350 Madison Ave., New York 17
JONES, G. M., 5415 S. Nottingham Ave., Chicago 38
JONES, I. R., Dairy Dept., Ore. State College, Corvallis
JONES, R. E., 593 Market St., San Francisco 15, Calif.
JONES, W. F., The Borden Co. Ltd., 393 Somerset St., Ottawa, Ont., Canada
JORDAN, W. G., The Borden Co., Waukesha, Wis.
JORDAN, W. K., Jacksonville, N. Y.
JOSEPHSON, D. V., Dairy Dept., Pa. State Univ., State College
JUDKINS, H. F., 260 Madison Ave., New York 16
JUKES, T. H., American Cyanamid Co., Pearl River, N. Y.
JUZI, W. H., Guernsey Breeders' Assoc., Harrisburg, Pa.

KAESER, Harold, 4871 Olentangy Rd., Columbus 2, Ohio
KALOYEREAS, SOCRATES, Dept. of Chem. & Biochem., La. State Univ., Baton Rouge
KANE, E. A., Bureau of Dairy Industry, Beltsville, Md.
KAPP, R. P., Box 5246, Columbia, S. C.
KASH, NORBERT, 1936 Hawthorne Ave., Waterloo, Iowa

KASLER, G. R., The Borden Co., Milwaukee, Wis.
KASSUBE, D. A., P.O. Box 31, Appleton, Wis.
KAUFMANN, O. W., Dept. of Food Technol., Univ. of Ill., Urbana
KEAY, JOHN, 530 Public Bldg., Calgary, Alberta, Canada
KEEN, R. H., Queen Dairy Co,. 413 S. Queen St., Lancaster, Pa.
KEENE, M. R., Route 5, Auburn, Maine
KEENER, H. A., Dept. of Dairy Husb., Univ. of N. H., Durham
KEENEY, D. G., 3 Ames Place, Morristown, N. J.
KEENEY, MARK, Dept. of Dairy Husb., Univ. of Md., College Park
KEITEL, KLAUS, Millstadt, Ill.
KELLER, D. S., 61 Ellington St., Longmeadow, Mass.
KELLER, F. M., 309 W. Jackson Blvd., Chicago
KELLEY, L. A., 1400 Porter Ave., Beloit, Wis.
KELLOGG, R. H., 1224 Alton Darby Rd., Columbus 4, Ohio
KELLY, P. L., Dairy Dept., Univ. of Neb., Lincoln
KEMPF, C. A., Intern. Dairy Supply Co. Ltd., 4706 Grove St., Oakland 9, Calif.
KENDALL, K. A., Dept. of Dairy Sci., Univ. of Ill., Urbana
KENDRICK, J. F., Bureau of Dairy Industry, Washington 25, D. C.
KENDRICK, J. W., School of Vet. Med., Univ. of Calif., Davis
KENNEDY, G. S., 515 8th St. S.W., Roanoke, Va.
KENNEDY, R. N., The Borden Co., 165 N. Washington Ave., Columbus 16, Ohio
KENNEDY, W. L., A & T College of N. C., Greensboro
KENT, O. B., Quaker Oats Company, Merchandise Mart Plaza, Chicago 54
KERN, C. L., Dairyman's League, 100 Park Ave., New York 17
KERR, C. B., 412 College Ave. S.E., Grand Rapids, Mich.
KESLER, E. M., Dairy Husb. Dept., Pa. State Univ., State College
KESSELRING, L. M., Kesselring Dairy, 1559 Triplett Blvd., Akron 6, Ohio
KETCHAM, W. J., 132 E. Tasher St., South Bend, Ind.
KEYES, E. A., Dairy Ind. Dept., Mont. State College, Bozeman
KIBLER, H. H., Dairy Dept., Univ. of Mo., Columbia
KILGORE, JAMES, Route 1, Northampton, Pa.
KILLICK, C. H. P., Dept. of Agr. & Immigration, Legislative Bldg., Winnipeg, Canada
KING, W. A., Dairy Dept., Clemson Agr. College, Clemson, S. C.
KIRCHOFF, GEORGE, Dept. of Health, Birmingham, Ala.
KIRK, J. J., 409 Maple Ave., Dubois, Pa.
KISSEN, BENJAMIN, Hygrade Food Products Corp., 177 Duane St., New York 13
KITCHEN, ERLE, 409 Huron St., Toronto, Ont., Canada
KNAYSI, GEORGE, Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y.
KNODT, C. B., Dept. of Dairy Husb., Pa. State Univ., State College
KNOOP, C. E., 1224 Alton-Darby Rd., Columbus 4, Ohio
KNOTT, J. C., Inst. of Agr. Sci., State College of Wash., Pullman
KNOX, J. E., Mound Valley Branch Exp., Mound Valley, Kan.
KNOX, W. D., Hoard's Dairyman, Fort Atkinson, Wis.
KNUDSEN, EDWIN, 814 E. 8th St., Trenton, Mo.
KOCH, H. R., 4346 Hillcrest Dr., Madison 5, Wis.
KOCH, I. O., The Borden Co., 165 N. Washington, Columbus 16, Ohio
KOCHER, D. S., 753 Shawnee, Leavenworth, Kan.
KOCHER, R. B., 658 Orchard Drive, Madison, Wis.
KOHLER, HENRY, 411 Banning Ave., White Bear Lake, Minn.
KOHLER, ROLAND, 2429 Beech St., Bakersfield, Calif.
KONEN, H. J., P.O. Box 236, Houston, Texas
KOPLAND, D. V., Huntley Field Station, Huntley, Mont.
KOSIKOWSKY, F. V., Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y.
KOZLIK, ROBERT, 421 W. Hancock, Stillwater, Minn.
KRATZER, C. R., The Borden Co., Arcade, N. Y.
KRAUSE, F. W., Pet Dairy Products, 909 Blackstone Ave., Waukesha, Wis.
KRAUSS, W. E., Ohio Agr. Expt. Sta., Wooster, Ohio
KRAVITZ, MAX, 133 Gorham St., Canandaigua, N. Y.
KREHBIEL, L. F., 3720 Hughes Ave., Los Angeles 34, Calif.
KREY, C. E., Southern Dairies, Inc., 60 M St., N.E., Washington 2, D. C.
KRIENKE, W. A., Dept. of Dairy Sci., Univ. of Fla., Gainesville
KRILL, W. R., College of Vet. Med., Ohio State Univ., Columbus
KRISTOFFERSON, THORVALD, Dairy Ind. Dept., Iowa State College, Ames
KRUKOVSKY, V. N., Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y.
KU, B. H. Y., 919 Walnut Lane, East Lansing, Mich.
KUBICEK, M. D., 1051 2nd, N.W., Mason City, Iowa
KUEBLER, JUSTA, 706 Maple Ave., Downers Grove, Ill.
KUMMEROW, F. A., Dept. of Food Technol., Univ. of Ill., Urbana
KUNKEL, R. W., Kraft Foods Co., Glenview, Ill.
KURTZ, ERVIN, Dairy Dept., S. D. State College, Brookings

LABEN, R. C., An. Husb. Dept., Univ. of Calif., Davis
LACHMANN, ALFRED, Stein Hall Co., Long Island City, N. Y.
LAKSHMANAN, S., Dairy Dept., Univ. of Md., College Park
LAMASTER, J. P., Dairy Dept., Clemson Agr. College, Clemson, S. C.
LAMB, D. O., Arden Sunfreeze Creameries, 1030 S. Main, Salt Lake City
LAMPERT, L. M., P.O. Box 1266, Sacramento, Calif.
LANE, C. B., Breakstone Bros. Inc., Walton, N. Y.
LANG, J. F., 7135 Boyer St., Philadelphia 19, Pa.
LANGHUS, W. L., 953 Clay Ct., Deerfield, Ill.
LARSEN, BERNHARD, Supplee-Wills-Jones Milk Co., 15 S. 34th St., Philadelphia 5, Pa.
LARSEN, P. B., Dept. of Dairy Husb., Utah State Agr. College, Logan

LARSON, B. L., Dept. of Dairy Sci., Univ. of Ill., Urbana
LARSON, C. J., Penfield Hill Road, Portland, Conn.
LARSON, G. L., 1326 Kane St., LaCrosse, Wis.
LARSON, R. A., Ind. Dairy Prod. Assoc., Board of Trade Bldg., Indianapolis 4, Ind.
LASSITER, C. A., Dairy Section, Univ. of Ky., Lexington
LATZER, R. L., 1401 Arcade Bldg., St. Louis 1, Mo.
LAUGHLIN, JOHN, Menzie Dairy Co., 1909 River St., McKeesport, Pa.
LAWHORN, R. K., Newton Square, Pa.
LAZAR, J. T., Dairy Dept., Clemson Agr. College, Clemson, S. C.
LAZARUS, N. E., 266 Bryant St., Buffalo 9, N. Y.
LEACH, C. A., Miller Bldg., Columbia, Mo.
LEAR, S. A., Dairy Husb. Dept., Rutgers Univ., New Brunswick, N. J.
LEBER, HENRY, 810 Burnet St., Syracuse, N. Y.
LEEDER, J. G., Dept. of Dairy Ind., Rutgers Univ., New Brunswick, N. J.
LEGATES, J. E., Dept. of An. Ind., N. C. State College, Raleigh
LEGRID, L. I., Route 1, Madison, Wis.
LEHMKUHL, HENRY, 73 Howell St., Rochester 7, N. Y.
LEIGHTON, RAMER, Dept. of Dairy Husb., Univ. of Minn., St. Paul
LEIGHTON, R. E., Dairy Dept., Texas A & M College, College Station
LENGACHER, JOHN, Route 1, Dundee, Ohio
LEONARD, H. A., Dept. of An. Ind., Univ. of Maine, Orono
LERBERG, CHARLES, Borden Food Products Co., Owatonna, Minn.
LESCURE, J. M., Fairfield Western Maryland Dairy, Linden Ave. & Dolphin St., Baltimore 3, Md.
LEVITAN, MEYER, 1200 Midwickhill Dr., Alhambra, Calif.
LEVOWITZ, DAVID, N. J. Dairy Labs., 226 Eastern Ave., New Brunswick, N. J.
LEWANDOWSKI, THADDEUS, Oakwood Terrace, Hamilton St., Norristown, Pa.
LEWIS, JOHN, 900 N.W. 130th St., Miami, Fla.
LEWIS, R. C., Dairy Dept., Mich. State College, E. Lansing
LINDQUIST, H. G., Dairy Ind. Dept., Univ. of Mass., Amherst
LINN, J. W., Dairy Husb. Dept., Kan. State College, Manhattan
LINSENMAYER, TAYLOR, West Lafayette, Ohio
LIST, W. H., Hotel Statler, New York 1
LITTLE, C. J., U.P. Expt. Sta., Chatham, Mich.
LITTLE, LAWRENCE, E. F. Drew & Co., 416 Division St., Boonton, N. J.
LIVELY, JACK, Route 5, Dallas, Texas
LOEWENSTEIN, MORRISON, Dept. of Dairying, Okla. A. & M College, Stillwater
LOFGREEN, G. P., An. Husb. Dept., Univ. of Calif., Davis
LOGAN, V. S., An. Husb. Div., Central Expt. Farm, Ottawa, Canada
LONG, H. F., Sugar Creek Creamery Co., Danville, Ill.
LOO, CHING CHEE, Carnation Co. Research Lab., 8015 Van Nuys Blvd., Van Nuys, Calif.
LOOMIS, V. M., P.O. Box 2482, Winston Salem, N. C.
LOOSLI, J. K., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
LOUDER, E. A., Pet Milk Co., Greenville, Ill.
LOUGH, O. G., 503 E. Oregon Ave., Phoenix, Ariz.
LOUGHARY, I. H., Dairy Sci. Dept., Wash. State College, Pullman
LOY, W. C., Wilson & Co., 4100 S. Ashland Ave., Chicago
LUCAS, H. L., Jr., Inst. of Statistics, N. C. State College, Raleigh
LUCAS, P. S., Dairy Dept., Mich. State College, East Lansing
LUDWICK, T. M., Dairy Husb. Dept., Ohio State Univ., Columbus
LUNDQUIST, N. S., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
LUSH, J. L., An. Husb. Dept., Iowa State College, Ames
LUSH, R. H., Dept. of Dairying, Univ. of Tenn., Knoxville
LUSK, J. W., Dept. of Dairy Husb., Miss. State College, State College
LUTHER, H. G., Chas. Pfizer & Co., 11 Bartlett St., Brooklyn 6, N. Y.
LYMAN, J. C., Golden State Co. Ltd., 425 Battery St., San Francisco, Calif.

MAACK, A. C., 4735 Seeley Ave., Downers Grove, Ill.
MACKENZIE, F. B., Albers Milling Co., 6130 S. Avalon Blvd., Los Angeles, Calif.
MACLEOD, PATRICIA, Dept. of An. Ind., Univ. of Conn., Storrs
MACVICAR, R. W., Agr. Chem. Research, Okla. A & M College, Stillwater
MACY, HAROLD, College of Agr., Univ. of Minn., St. Paul 1
MADDUX, J. N., Reidsville, Ga.
MAGRABI, M. H., Chem. Sec. Ministry of Agric., Orman-Giza, Cairo, Egypt
MAHAN, W. J., Gen. Foods Corp., St. Clair, Mich.
MAINA, MYRTLE, Kraft Foods Co., 923 Waukegan Rd., Glenview, Ill.
MALKAMES, J. P., Bureau of Dairy Ind., Beltsville, Md.
MALLORY, T. E., Bland, Va.
MANERA, A. B., 1258 Douglas Ave., North Providence, R. I.
MANN, H. L., Dept. of Dairy Husb., Pa. State Univ., State College
MANUS, L. J., 2013 Lake St., Pullman, Wash.
MANWARING, D. H., Nelson-Ricks Creamery Co., Rexburg, Idaho
MARCH, RICHARD, Ellis Hollow Rd., Ithaca, N. Y.
MARCUS, THEODORE, 577 Blue Hill Ave., Roxbury 21, Mass.
MARION, G. B., Dairy Husb. Dept., Kan. State College, Manhattan
MARLAND, R. E., Coble Dairy Prod., Newberry, S. C.
MARQUARDT, J. C., 14 Maxwell Ave., Geneva, N. Y.
MARSHALL, S. P., Dept. Dairy Sci., Univ. of Fla., Gainsville
MARTIN, W. H., Dept. of Dairy Husb., Kan. State College, Manhattan
MASON, R. W., Mgr. Osborn Prison Farm, Somers, Conn.
MARTIN, R. L., 1936 Clinton St., Toledo, Ohio
MARTINEZ CH., RODRIGO, San Jose, Costa Rica
MARTY, I. M., 902 Municipal Bldg., Baltimore, Md.
MATHER, GEORGE, 1110 Pleasant St., Oak Park, Ill.

MATHER, R. E., Dairy Research Station, Sussex, N. J.
MATHER, ROBERT, 338 Gertrude St., Elgin, Ill.
MATTHEWS, C. A., Bureau of Dairy Industry, Beltsville, Md.
MATTICK, J. F., Dairy Dept., Univ. of Md., College Park
MATTSON, H. A., Ives Ice Cream Co., Minneapolis, Minn.
MAXCY, R. B., George J. Meyer Mfg. Co., Milwaukee 1, Wis.
MAYBEE, G. R., Fry-Cadbury Ltd., 2025 Masson St., Montreal 34, Quebec, Canada
MAYFIELD, SCOTT, Mayfield Farms, Athens, Tenn.
MAYNARD, L. A., Dept. of Biochem., Cornell Univ., Ithaca, N. Y.
MCCALL, RALPH, The Quaker Oats Company, Merchandise Mart Plaza, Chicago 54
MCCAN, J. C., 246 Grant Ave., Highland Park, N. J.
MCCANDLESS, J. C., Route 5, Butler, Pa.
MCCHESNEY, E. R., Fairmount Creamery Co., Buffalo, N. Y.
MCCLARREN, HOWARD, 4721 Ellicott St. N.W., Washington, D. C.
MCCLURE, R. J., Cherry-Burrell Corp., 447 Morgan St., Cincinnati 6, Ohio
MCCULLOUGH, M. E., An. Ind. Dept., Georgia Agr. Sta., Experiment, Ga.
MCDOWALL, F. H., Dairy Research, Box 602, Palmerton N, New Zealand
MCFARLAND, G. C., 6202 N. Sultana Ave., Temple City, Calif.
MCFARREN, E. F., Environmental Health Center, 1014 Broadway, Cincinnati 2, Ohio
MCGILLIARD, L. D., An. Husb. Dept., Iowa State College, Ames
MCGILLIARD, P. C., Dairy Dept., Okla. A & M College, Stillwater
MCGLASSON, E. D., Dept. of Dairy Husb., A & M College of Texas, College Station
MCGRAIL, G. M., 5920 N. Fourth St., Philadelphia 20, Pa.
MCGREW, C. D., Dept. of Dairy Sci., Ohio State Univ., Columbus
MCINTIRE, J. M., 297 Blackhawk Rd., Riverside, Ill.
MCINTOSH, O. O., Ralston-Purina Co., St. Louis 2, Mo.
MCKELLAR, E. K., Dairy Dept., Colo. A & M College, Fort Collins
MCLEOD, H. J., Dept. of Dairy Husb., N. D. Agr. College, Fargo
MCMAHAN, J. H., 175-46 Murdock Ave., St. Albans, L. I., N. Y.
MCMAHON, HARRY, 2314 Manchester, Birmingham, Mich.
MCMILLAN, W. D., G.L.F. Exchange, Ithaca, N. Y.
MCNIEL, N. A., Box 2612, College Station, Texas
MEAD, S. W., Dept. of An. Husb., Univ. of Calif., Davis
MEADE, R. K., Western Condensing Co., 240 E. Edwards St., Lima, Ohio
MECHAM, C. M., T.C.A. Monrovia, Liberia, Dept. of State, Washington 25, D. C.
MEISER, J. A., Jr., Dairy Dept., Mich. State College, East Lansing
MEITES, JOSEPH, Dept. of Physiology & Pharm., Mich. State College, East Lansing
MELHUISH, V. P., 9100 W. 18th St., Los Angeles 55, Calif.
MELICK, L. T., 426 Memorial Ave., Grove City, Pa.
MERCIER, ERNEST, Experimental Sta., Lennoxville, Quebec, Canada
MERIDITH, P. W., 1320 W. 12th, Kansas City, Mo.
MERILAN, C. P., Dept. of Dairy Husb., Univ. of Mo., Columbia
MERRILL, H. J., Velda Dairy Farms Inc., Tallahassee, Fla.
METZGER, JACOB, Metzger Dairies, Dallas 1, Texas
MEYER, C. H., Route 5, Wayzata, Minn.
MEYER, E. C., Hoard's Dairyman, Ft. Atkinson, Wis.
MICHAUD, LAURENT, Vet. Research Dept., Merck & Co. Inc., Rahway, N. J.
MICKLE, J. B., Dairy Dept., Oklahoma A & M College, Stillwater
MIERSCH, R. E., 460 N. Sidney St., Kimberly, Wis.
MIKOLAJCIK, EMIL, College of Agr., Mayaguez, Puerto Rico
MILES, J. T., 2139 Sunset Dr., Ames, Iowa
MILLER, DONALD, Dairy Dept., N. M. College of Agr. & Mech. Arts, State College
MILLER, G. D., Dept. of Dairying, La. State Univ., Baton Rouge
MILLER, N. J., Mead Johnson & Co., Evansville, Ind.
MILLER, P. G., Thomas J. Lipton, Inc., Hoboken, N. J.
MILLER, WALLACE, New Prague, Minn.
MILLER, W. C., Garst Bros. Dairy, Roanoke, Va.
MILLER, W. J., Dairy Dept., Univ. of Ga., Athens
MILNER, F. W., 145 S. Spring, Los Angeles 12, Calif.
MINDLING, LUTHER, 447 Linden Ave., Miamisburg, Ohio
MINOR, L. H., 27632 Arsenal Rd., Flat Rock, Mich.
MITTEN, H. L., Jr., 320 Jefferson St., Ft. Atkinson, Wis.
MIXNER, J. P., Dairy Research Station, Sussex, N. J.
MODEN, GILMER, 305 Sheridan St., Albert Lea, Minn.
MOELLER, A. N., Dairy Science Dept., Univ. of Ill., Urbana
MOHR, C. A., 2724 Regent St., Madison 5, Wis.
MOJONNIER, R. W., 327 S. Michigan Ave., Pasadena 5, Calif.
MOLANO C, JOAQUIN, Carrera 5 No. 54-20, Bogota, Colombia, S. A.
MONIER, H. B., College Station, Berea, Ky.
MONROE, C. F., 421 Woodland Ave., Wooster, Ohio
MONTEALEGRE, R. J., P.O. Box 173, San Jose. Costa Rica
MOODY, E. G., Agr. Dept., Ariz. State College, Tempe
MOOK, D. E., 30 Secor Rd., Scarsdale, N. Y.
MOORE, A. V., Dairy Dept., Texas A & M College, College Station
MOORE, C. W., Cowles Chemical Co., 7016 Euclid Ave., Cleveland 3, Ohio
MOORE, H. C., Dairy Dept., Univ. of N. H., Durham
MOORE, L. A., Bureau of Dairy Ind., Beltsville, Md.
MOORE, R. D., 3208 Regent St., Erie, Pa.
MORGAN, M. E., Dept. of An. Ind., Univ. of Conn., Storrs
MORGAN, ROY, Jo-Mar Dairy, Iron St., Salina, Kan.
MORLEY, L. W., Michigan Milk Prod. Assoc., 406 Stephenson Bldg., Detroit, Mich.
MORRIS, A. J., Dairy Husb. Dept., Utah State Agr. College, Logan

MORRIS, H. A., Dairy Div., Univ. of Minn., St. Paul
MORRIS, L. C., Rice Hall, Cornell Univ., Ithaca, N. Y.
MORRISON, F. B., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
MORRISON, H. B., Dairy Dept., Univ. of Ky., Lexington
MORRISON, J. S., The Borden Co., Tillsonburg, Ont., Canada
MORRISON, R. A., 103 Selby Blvd., Worthington, Ohio
MORRISON, S. H., Dairy Dept., Univ. of Ga., Athens
MORROW, K. S., Dairy Husb. Dept., Univ. of N. H., Durham
MORTENSEN, O. L., 2145 Market St., Denver 2, Colo.
MOSELEY, W. K., 3862 E. Washington St., Indianapolis 1, Ind.
MOSLE, H. B., Fair Meadows, Litchfield, Conn.
MOTZOK, I., Dept. of Nutrition, Ontario Agr. College, Guelph, Canada
MUCHA, T. J., 8416 14th Place, Hyattsville, Md.
MUELLER, W. S., Dept. of Dairy Ind., Mass. State College, Amherst
MULL, L. E., Dept. of Dairy Sci., Univ. of Fla., Gainesville
MUMMERT, R. J., P.O. Box 261, Mifflin, Pa.
MUNDT, J. O., Bacteriology Dept., Univ. of Tenn., Knoxville
MUR, ANTONIO GODED Y., Apartado 441, Zaragoza, Spain
MURDOCK, F. R., Western Wash. Expt. Sta., Puyallup, Wash.
MURLEY, W. R., Dept. of An. Ind., N. C. State College, Raleigh
MURRAY, D. L., Dairy Husb. Dept., Mich State College, East Lansing
MUSGRAVE, S. D., Dept. of Dairying, Okla. A & M College, Stillwater
MUSHER, SIDNEY, 250 W. 57th St., New York 19
MUSSETT, A. T., Beatrice Foods Co., 1526 S. State St., Chicago 5
MYERS, E. M., New York School of Agr., Alfred, N. Y.
MYERS, R. P., Environmental Health Center, 1014 Broadway, Cincinnati 2, Ohio
MYKLEBY, R. W., Land O'Lakes Creamery, 2201 Kennedy St. N.E., Minneapolis, Minn.

NADAL, R. A., An. Husb. Dept., Univ. of Puerto Rico, Mayaguez, P. R.
NADELIN, E. P., 654 College Ave., Wooster, Ohio
NAFIS, L. F., Georgian Hotel, Evanston, Ill.
NAGEOTTE, G. J., Dairy Husb. Dept., Va. Polytechnic Inst., Blacksburg
NAGEOTTE, JOE, Dairy Husb. Dept., Pa. State Univ., State College
NAIR, J. H., Continental Foods, Inc., Hoboken, N. J.
NASH, N. N., Lanco Prod. Corp., 601 W. 26th St., New York 1
NEAL, W. M., Route 6, Tampa 4, Fla.
NEILSEN, SIGURD, The Federation of Danish Dairy Assoc., Radhuspladsen 3, Aarjus, Denmark
NELSON, D. H., Dairy Ind. Dept., Univ. of Mass., Amherst
NELSON, F. E., Dairy Ind. Dept., Iowa State College, Ames
NELSON, H. G., Box 27, College Station, Hammond, La.
NELSON, H. G., Div. of Public Health, City Hall, Minneapolis 15, Minn.
NELSON, J. A., Dept. of Dairy Ind., Mont. State College, Bozeman
NELSON, J. W., Nutrena Mills Inc., 200 Grain Exchange Bldg., Minneapolis 15, Minn.
NELSON, VICTOR, Food Machinery Corp., San Jose 5, Calif.
NELSON, W. O., Dairy Sci. Dept., Univ. of Ill., Urbana
NESBITT, JACK, Dept. of Dairy Sci., U. of M., Winnipeg, Manitoba, Canada
NESS, A. R., Dept. of An. Husb., MacDonald College of McGill Univ., Quebec, Canada
NEUMAN, P. E., Beacon Milling Co., Cayuga, N. Y.
NEUMANN, H. D., New Haven Dairy Div., General Ice Cream Corp., New Haven, Conn.
NEVENS, W. B., Dept. of Dairy Sci., Univ. of Ill., Urbana
NEWLANDER, J. A., Dept. of An. & Dairy Ind., Univ. of Vt., Burlington
NEWSOME, JOE, Barnesville, Ga.
NEWTON, E. E., Creameries of America, 325 Roosevelt Bldg., Los Angeles 14, Calif.
NIBLER, C. W., Dairy Husb. Dept., Univ. of Neb., Lincoln
NICKERSON, T. A., Dept. of Dairy Ind., Univ. of Calif., Davis
NIEDERMEIER, R. P., Dairy Husb. Dept., Univ. of Wis., Madison
NIELSEN, V. H., Dept. of Dairy Ind., Iowa State College, Ames
NIELSEN, V. W., 1600 N. Gillett St., Appleton, Wis.
NORTH, G. C., Beatrice Foods Co., 1526 S. State St., Chicago
NORTHERN, W. L., 514 Davis Ave., Morgantown, W. Va.
NORTON, C. L., Dairy Dept., Okla. A & M College, Stillwater
NORTON, H. W., Jr., Holstein-Friesian Assoc. of America, Brattleboro, Vt.
NUPSON, HENRY, 212 Woolworth Bldg., New Ulm, Minn.
NUPSON, H. N., 506 E. 2nd St., Redwood Falls, Minn.
NUSBAUM, DAVE, 246 N. Main Blvd., Green Bay, Wis.

OBERG, E. B., 8015 Van Nuys Blvd., Van Nuys, Calif.
O'DELL, W. T., Dept. of Dairy Husb., Pa. State Univ., State College
O'DONNELL, E. J., Klenzade Products Inc., Beloit, Wis.
OKULITCH, G. J., Fraser Valley Milk Prod. Assoc., 425-8th Ave., N.W., Vancouver, B. C., Canada
OLDS, DURWARD, 603 W. Green St., Urbana, Ill.
OLMSTEAD, R. H., Dept. of Dairy Husb., Pa. State Univ., State College
OLSEN, L. S., Olsen Publishing Co., 1445 N. 5th St. at W. Cherry, Milwaukee 12, Wis.
OLSON, C. C., Dairy Div., N. D. Agr. College, Fargo
OLSON, F. C., 207 N. Allen St., Madison, Wis.
OLSON, H. C., Dept. of Dairying, Okla. A & M College, Stillwater
OLSON, H. H., Curtiss Candy Co. Farm, Cary, Ill.
OLSON, J. C., Jr., Dept. Dairy Bact., Univ. of Minn., St. Paul

OLSON, R. T., City Health Dept., Spokane, Wash.
OLSSON, C. B., Dairy Dept., Univ. of N. H., Durham
OMMODT, B. J., 2702 Valley Dr., Alexandria, Va.
ORDERS, W. C., 2711 Rosedale Ave., Raleigh, N. C.
ORMISTON, E. E., Dept. of Dairy Sci., Univ. of Ill., Urbana
ORMOND, N. H., 322 Ash St., Park Forest, Ill.
ORMSBEE, ROBERT, 2076 E. Fremont St., Stockton, Calif.
ORTMAN, C. K., 625 Cleveland Ave., Columbus, Ohio
OSBORN, F. H., Falls Cities Coop. Milk Prod. Assoc., 1051 E. Main St., Louisville, Ky.
OTTESON, D. O., 1911½ 10th St., Monroe, Wis.
OTTING, BERT, Carnation Milk Co., Oconomowoc, Wis.
OTTING, H. E., 2701 Minerva Lake Rd., Columbus 11, Ohio
OTTO, B. F., Otto's Suburban Dairy Inc., Camp Horne Rd., Pittsburgh 2, Pa.
OVERCAST, W. W., Dept. of Dairying, Univ. of Tenn., Knoxville
OVERMAN, ORTON, Route 2, Union City, Ind.
OWEN, TOM, Brown-Forman Distillers Corp., Louisville 1, Ky.

PABST, FRED, Pabst Farms Inc., Oconomowoc, Wis.
PAINTER, W. E., 1949 Third Ave., Sacramento, Calif.
PAISLEY, E. H., 415 Continental Rd., Hatboro, Pa.
PALEY, CHARLES, Certified Laboratories Inc., 19 Hudson St., New York 13
PALLAS, G. E., 800 W. River St. N., Elyria, Ohio
PALMER, W. H., 4550 S. Sherman, Englewood, Colo.
PARFITT, E. H., Evap. Milk Assoc., 228 N. LaSalle St., Chicago
PARKER, J. B., Bureau of Dairy Industry, Washington 25, D. C.
PARKHURST, R. T., Lindsey-Robinson & Co., Roanoke 3, Va.
PARKIN, I. E. Dept. of Dairy Husb., Pa. State Univ., State College
PARMELEE, C. E., Dairy Husb. Dept., Purdue Univ., Lafayette, Ind.
PARRISH, D. B., Dept. of Chem., Kan. State College, Manhattan
PARRISH, J. R., Dairy Husb. Dept., Ala. Polytechnic Inst., Auburn
PARSONS, C. H., 37 Fairview Way, Amherst, Mass.
PARSONS, G. E., Dairy Dept., Mich. State College, East Lansing
PASHKOW, A. D., 415 W. Scott St., Chicago 10
PATRICK, T. E., Dairy Dept., La. State Univ., Baton Rouge
PATTON, STUART, Dairy Husb. Dept., Pa. State Univ., State College
PAXTON, JOHN, 244 Morgan St., Oberlin, Ohio
PEACE, E. J., 1106 S. 3rd St., Hamilton, Mont.
PEARSON, A. M., 69 Fairview Blvd., Guelph, Ont., Canada
PEARSON, P. B., Div. of Biology & Medicine, Atomic Energy Commission, Washington 25, D. C.
PEDERSON, M. G., Price's Creameries, Inc., El Paso, Texas
PEDRICK, R. F., 1019 Franklin Pl., Rockford, Ill.
PEEBLES, D. D., Western Condensing Co., 411 Battery St., San Francisco, Calif.
PEET, H. S., Hatch Dairy Expt. Sta. Farm, Oakwood, Mo.
PEKERIS, A. M., Farmers & Consumers Dairy, Morristown, N. J.
PELISSIER, C. L., Agr. Ext. Service, Univ. of Calif., Davis
PENCE, J. T., Dairymen's League Laboratory, 810 Burnet Ave., Syracuse, N. Y.
PERRY, E. J., Dept. of Dairy Husb. and Mfrs., N. J. Agr. College, New Brunswick
PERRY, J. R., 26 Midland Ave., East Orange, N. J.
PETERS, ISAAC, Dairy Husb. Dept., Texas A & M College, College Station
PETERSEN, W. E., Dairy Husb. Dept., Univ. of Minn., St. Paul
PETERSON, J. B., Roseoe, Ill.
PETERSON, MERRITT, McDonald Coop Dairy Co., 23020 Buckingham, Dearborn, Mich.
PFAU, K. O., Dairy Research Station, Sussex, N. J.
PFEFFER, J. C., 233 Scenic Ave., Piedmont, Calif.
PFEIFER, G. B., 4800 Emerson Ave. S., Minneapolis 9, Minn.
PFUEGER, C. C., Bridgeman Creamery, Minot, N. D.
PHILLIPS, C. A., Dept. of Dairy Ind., Univ. of Calif., Davis
PHILLIPS, P. H., Dept. of Biochem., Univ. of Wis., Madison
PIERCE, C. W., Dept. of Agr. Econ., Pa. State Univ., State College
PIERCE, W. W., 70 Arlington St., Haverhill, Mass.
PIRIE, J. W., Box 1751, Cedar Rapids, Iowa
PISANI, J. P., Box 408, Church St., Bohemia, N. Y.
PLESNER, J. S., Chr. Hansen's Lab. Inc., Little Falls, N. Y.
PLUM, MOGENS, 4503 Madison St., Lincoln, Neb.
POE, C. F., Univ. of Colo., Boulder
POLIVKA, J. D., Wil-O-Way Farm, Naperville, Ill.
POPE, D. B., 1364 W. Michigan Ave., Battle Creek, Mich.
POPE, S. M., Tolibia Cheese Mfg. Corp., 45 E. Scott St., Fond du Lac, Wis.
PORTER, A. R., Dept. of Dairy Husb., Iowa State College, Ames
PORTER, C. C., Lesage, W. Va.
PORTERFIELD, I. D., Dept. of Dairy Husb., W. Va. Univ., Morgantown
POTTER, F. E., Dairy Dept., Pa. State Univ., State College
POU, J. W., An. Ind. Dept., N. C. State College, Raleigh
POUNDEN, W. D., Dept. of Vet. Sci., Ohio Agr. Expt. Sta., Wooster
POWELL, M. E., Knudsen Creamery, 1974 Santee St., Los Angeles 11, Calif.
POWER, F. W., 3920 Division St., Los Angeles 65, Calif.
POWERS, A. J., Bordens Farm Products Co., 90 Third Ave., Brooklyn, N. Y.
POWERS, RAYMOND, The Borden Co., 350 Madison Ave., New York 17
PRATT, A. D., Dairy Ind. Dept., Ohio Agr. Expt. Sta., Wooster
PRATT, H. R., Klenzade Ohio Co., Elyria, Ohio
PRATT, H. T., Phila. Dairy Prod. Co., Philadelphia 5, Pa.
PRATT, S. E., Union Grove, Wis.
PRENTICE, J. R., 325 N. Wells St., Chicago 10

PRICE, D. C., Dairy Dept., Clemson Agr. College, Clemson, S. C.
PRICE, R. B., Price's Creameries, P.O. Box 3008, El Paso, Tex.
PRICE, W. V., Dept. of Dairy & Food Ind., Univ. of Wis., Madison
PRICKETT, P. S., Mead Johnson & Co., Evansville, Ind.
PROHASKA, J. R., The Borden Co., 920 Palmyra Ave., Dixon, Ill.
PROUTY, C. C., Dairy Sci. Dept., State College of Wash., Pullman
PULKRABEK, G. M., 1616 17th St., Monroe, Wis.
PURSLEY, G. R., Dept. of An. Ind., Univ. of Ark., Fayetteville
PUTNAM, D. N., American Jersey Cattle Club, 1521 East Broad St., Columbus 15, Ohio
PUTNAM, G. U., 1042 Pontiac Rd., Wilmette, Ill.
PUTNEY, C. C., 49 Seminary St., Brandon, Vt.
PYENSON, HARRY, Reddi-Wip Inc., 4205 Forest Park Blvd., St. Louis 8, Mo.

QUAYLE, J. R., 2688 Fessey Court, Nashville 4, Tenn.
QUEEN, W. W., 406 E. Madison Ave., Springfield, Ohio
QUENCER, A. B., 620 12th Ave., New York 19
QUIGLEY, J. V., Chapman Dairy Prod., 1217 Harrison St., Kansas City 10, Mo.
QUIRCH, EDUARDO, Calle 35 No. 1463 ent. 26 y 28, Nuevo Vedado, Habana, Cuba
QUIROS, JORGE, Apartado 1285, San Jose, Costa Rica

RAGSDALE, A. C., Dept. of Dairy Husb., Univ. of Mo., Columbia
RAITHBY, G., An. Husb. Dept., Ontario Agr. College, Guelph, Ont., Canada
RALSTON, N. P., Dairy Dept., Mich. State College, East Lansing
RAMSAY, R. J., Harper Rd., Solon, Ohio
RAPS, GREG, N. 12th St., Des Moines, Iowa
RASMUSSEN, H. L., 2850 Barlow St., Madison 5, Wis.
RASMUSSON, FREDERICK, Rieck McJunkin Dairy, Forbes & Stevenson Sts., Pittsburgh 19, Pa.
RATHBUN, GORDON, Esmond Dairy, Sandusky, Ohio
RATZLAFF, ALFRED, Marigold Dairies, Rochester, Minn.
REAVES, C. W., Dept. of Dairy Sci., Univ. of Fla., Gainesville
REAVES, P. M., Dept. of Dairy Husb., Va. Polytechnic Inst., Blacksburg
RECORD, P. R., Security Mills, Knoxville, Tenn.
REDFERN, R. B., Dept. of An. Ind., N. C. State College, Raleigh
REECE, R. P., Dept. of Dairy Husb., N. J. Agr. Expt. Sta., New Brunswick
REED, ALEX, Southern Ill. Univ., Carbondale, Ill.
REED, RACHEL L., The Borden Co., 350 Madison Ave., New York 17
REEDAL, JOHN, A. O. Smith Corp., Milwaukee 1, Wis.
REESMAN, K. G., 1008 Meadows St., New Bern, N. C.
REEVES, C. B., 1804 Grant Ave., Wilmington, Del.
REEVES, R. H., Carlson-Frink Co., Denver 1, Colo.
REGAN, M. J., Dairy Dept., Univ. of Mo., Columbia
REGAN, W. M., Agr. Expt. Sta., Davis, Calif.
REGER, J. V., 904 N. Jefferson St., Little Chute, Wis.
REID, J. T., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
REID, W. H. E., Dept. of Dairy Husb., Univ. of Mo., Columbia
REINBOLD, G. W., Telegraph Rd., Deerfield, Ill.
REINEKE, E. P., Dept. of Physiol. & Pharm., Mich. State College, East Lansing
REINKE, E. F., 1640 Summit, Cincinnati 37, Ohio
REITH, H. E., Route 1, Perkasie, Pa.
REMALEY, R. J., 959 Alfini Dr., Des Plaines, Ill.
RHOADES, P. L., 2776 Albrecht Ave., Akron, Ohio
RHODE, C. S., Dept. of Dairy Sci., Univ. of Ill., Urbana
RICE, FRANK, Evaporated Milk Assoc., 228 N. LaSalle St., Chicago 1
RICE, V. A., Dept. of An. Husb., Univ. of Mass., Amherst
RICH, J. L., P.O. Box 868, Ogden, Utah
RICH, L. H., Dept. of Dairy Husb. & Mfg., Utah State Agr. College, Logan
RICHARDS, C. R., Dept. of An. & Poultry Ind., Univ. of Del., Newark
RICHARDS, E. L., Box 99, Three Rivers, Mich.
RICHARDSON, G. A., Dept. of Dairy Husb., Ore. State College, Corvallis
RIDDELL, W. H., Dept. of An. & Dairy Husb., Univ. of Vt., Burlington
RIDOUT, F. M., St. Margaret's, Annapolis, Md.
RIGGS, L. K., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
RISHOI, A. H., Cherry-Burrell Corp., 427 W. Randolph St., Chicago
RIVERO-LARRABURE, JUAN ANTONIO, Casilla 314, Lima, Peru
RIVERS, P. W., Southwestern La. Inst., Lafayette
ROAHEN, D. C., 517 S. 4th E., Fort Atkinson, Wis.
ROARK, D. B., Dairy Dept., Miss. State College, State College
ROBERTS, J. O., 386 S. Terrace Ave., Columbus 4, Ohio
ROBERTS, R. E., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
ROBERTS, W. M., Dept. of An. Ind., N. C. State College, Raleigh
ROBERTSON, A. H., N. Y. State Dept. of Agr. & Mkts., Albany, N. Y.
ROBERTSON, E. I., John W. Eshelman & Sons, Lancaster, Pa.
ROBICHAUX, R. P., Goldenrod Creamery Co., Brodhead, Wis.
ROGERS, C. A., 8731 Witt St., Detroit, Mich.
ROLAND, C. T., Calgon, Inc., P.O. Box 1346, Pittsburgh, Pa.
ROLEN, WALLACE, Kraft Foods Co., South Edmeston, N. Y.
ROLLINS, GILBERT, Dept. of Dairy Sci., Univ. of Ill., Urbana
ROLLINS, N. W., Dept. of An. Husb. Cornell Univ., Ithaca, N. Y.
RONNING, MAGNAR, Dept. of Dairying, Okla. A & M College, Stillwater
ROSENBAUM, ROBERT, 3743 D St., Philadelphia 24, Pa.
ROSENBERGER, W. S., Dairy Ind. Dept., Iowa State College, Ames
ROSENEAU, FRED, 425 1st Ave., S.W., Great Falls, Mont.

Ross, H. A., The Borden Co., 350 Madison Ave., New York 17
Ross, R. H., Dept. of Dairy Husb., Univ. of Idaho, Moscow
Rougeou, C. L., Dairy Dept., Southwestern La. Inst., Lafayette
Roundy, Zola D., 17 McIntosh Ave., Clarendon Hills, Ill.
Ruch, Erwin, Inredeo Inc., 1 Atlantic St., Stamford, Conn.
Rudnick, A. W., 214 S. Russell Ave., Ames, Iowa
Rudnick, A. W., Jr., 1464 Holton, St. Paul E-4, Minn.
Rue, J. B., 1810 W. Genesee St., Syracuse 4, N. Y.
Rueda, Ing. Leopoldo, Compania Colombiana de Alimentos, Lacteos S.A., Bugalagrande Valle, Colombia, S.A.
Rumler, R. H., Holstein-Friesian Assoc. of America, Brattleboro, Vt.
Rupel, I. W., Dairy Husb. Dept., Texas A & M College, College Station
Rusoff, L. L., Dept. of Dairying, La. State Univ., Baton Rouge
Russell, James, Kitsap Dairymens Assoc., P.O. Box 314, Bremerton, Wash.
Russell, O. M., 753 Stanton St., Pasadena 3, Calif.
Rutz, W. D., Dairy Husb. Dept., Kan. State College, Manhattan
Ryan, C. E., Meridian Grain-Elevator Co., P.O. Box 284, New Orleans, La.
Rydzewski, George, 1605 S. 37th St., Milwaukee, Wis.
Rygg, A. R., P.O. Box 602, Everett, Wash.
Ryser, F. C., 1524 Branch Ave., S.W., Cleveland 13, Ohio

Saarinen, Pellervo, Univ. of Helsinki, Viikin Koetila, Miami, Finland
Sachs, S. E., 628 Clarence, Oak Park, Ill.
Sager, O. S., Bureau of Dairy Industry, Washington 25, D. C.
Salisbury, G. W., Dept. of Dairy Sci., Univ. of Ill., Urbana
Salisbury, S. M., Dept. of Dairy Sci., Ohio State Univ., Columbus
Salsbury, R. L., Mich. State College, Dept. of Bact. & Pub. Health, East Lansing
Sampey, J. J., Abbotts Dairies, Inc., 238 Lombard St., Philadelphia 47, Pa.
Sanders, G. P., Bureau of Dairy Industry, Washington 25, D. C.
Sanders, L. R., 257 Highland Dr. N.W., Cedar Rapids, Iowa
Sandhouse, H. A., Dept. of An. & Dairy Ind., Colo. A & M College, Ft. Collins
Sangle, B. T., Near Naik's Wada, Dhulia (Old), W. Khandesh, Bombay State, India
Sargent, Gordon, Box 1398, Opa Locka, Fla.
Sartori, Joseph, 6 South St., Plymouth, Wis.
Sauber, D. A., Darimix Control Co., LaCrosse, Wis.
Saylor, Nathaniel, Dairy Dept., Florida A & M College, Tallahassee
Scaramella, E. L., Kraft Foods Co., 2160 Newhall St., San Francisco, Calif.
Schabinger, J. R., Dairy Husb. Dept., Univ. of Md., College Park
Schaefer, W. E., Jr., NEPA Artificial Breeding Coop., Tunkhannock, Pa.
Scharf, Irvin C., Floyd Knobs, Ind.
Scheidenhelm, E. C., Dept. of Dairy Husb., Univ. of Ky., Lexington 29
Schipper, I. A., Dairy Div., Univ. of Minn., St. Paul
Schlichting, J. E., 1882 10th St., Monroe, Wis.
Schmiege, C. C., 1165 Oakwood Ave., DesPlaines, Ill.
Schmit, Ray, 2206 N. 30th St., Milwaukee, Wis.
Schneider, C. J., 2001 Chestnut St., St. Louis 3, Mo.
Schneider, Kilian, Arkport, N. Y.
Schnell, L. E., Route 2, Apple Creek, Ohio
Schnitzer, J. B., Sani-Pure Dairy Lab., 178 Saddle River Rd., Rochelle Park, N. J.
Schoolcraft, G. W., 105 N. Richardson Dr., Somerset, Ky.
Schrenk, O. J., Bowman Dairy, 140 W. Ontario, Chicago
Schroer, C. J., 137 N. 8th St., Upper Sandusky, Ohio
Schulte, R. F., Brock-Hall Dairy Co., 1204 Whitney Ave., Hamden, Conn.
Schultz, J. M. J., 606 3rd St., West De Pere, Wis.
Schultz, L. H., An. Husb. Dept., Cornell Univ., Ithaca, N. Y.
Schwarz, L. R., 1310 14th St., Oakland, Calif.
Scott, E. C., Ashton, Ill.
Scott, H. T., The Wis. Alumni Research Found., Univ. of Wis., Madison 6
Scott, J. C., Route 1, McKees Rocks, Pa.
Searles, H. R., Dairy Husb. Dept., Univ. of Minn., St. Paul
Searls, E. N., Milk Dealers' Assoc., 25 Fourth Ave., Newark 4, N. J.
Seath, D. M., Dept. of An. Ind., Univ. of Ky., Lexington
Seath, R. W., Box 384, Owatonna, Minn.
Seiberling, D. A., Dept. of Dairy Technol., Ohio State Univ., Columbus
Seipp, E. A., Jr., Golden State Co., Ltd., 425 Battery St., San Francisco 11, Calif.
Sell, O. E., Ga. Expt. Sta., Experiment, Ga.
Senadenos, T. S., 9753 Medford Dr., St. Louis County 21, Mo.
Senger, M. E., Dept. of An. Ind., N. C. State College, Raleigh
Sentfen, E. R., 3717 McKinney Ave., Dallas 4, Texas
Shadwick, G. W., Jr., Beatrice Creamery Co., 1526 S. State St., Chicago 5
Shafer, Reed, Greenville, Ohio
Shaffer, H. E., Dept. of Dairy Husb., Pa. State Univ., State College
Shannon, F. P., Dept. of An. Ind., Univ. of Conn., Storrs
Shapiro, Max, Dept. of Health, Rochester, N. Y.
Sharp, P. F., College of Agr. Expt. Sta., Univ. of Calif., Berkeley
Shaul, John, 124 Birr St., Rochester, N. Y.
Shaw, A. O., Dept. of Dairy Husb., Wash. State College, Pullman
Shaw, J. C., Dept. of Dairy Husb., Univ. of Md., College Park
Shawyer, S. R., The Borden Co. Ltd., Spadina Crescent, Toronto, Ont., Canada
Shelby, C. E., U. S. Range Livestock Expt. Sta., Miles City, Mont.
Sheldon, F. M., 1097 S. Marengo Ave., Pasadena 5, Calif.

SHELTON, E. M., 4614 Prospect Ave., Cleveland 3, Ohio
SHEPARDSON, C. N., School of Agr., Texas A & M College, College Station
SHEPHERD, J. B., 2801 Tifton St. S., Gulfport, Fla.
SHERE, LEWIS, The Diversey Corp., 1820 Roscoe St., Chicago 13
SHERMAN, J. M., Dairy Ind. Dept., Cornell Univ., Ithaca, N. Y.
SHERWOOD, R. W., 731 K St., Davis, Calif.
SHEURING, J. J., Dept. of Dairy Husb., Univ. of Ga., Athens
SHIELDS, J. B., 425 Battery St., San Francisco, Calif.
SHIPE, W. F., Dairy Ind. Dept., Cornell Univ., Ithaca, N. Y.
SHIPSTEAD, HELGE, Dairy Ind. Dept., Univ. of Calif., Davis
SHOGREN, C. B., Klenzade Products Inc., Beloit, Wis.
SHOTWELL, T. C., 35 Salter Place, Maplewood, N. J.
SHRADER, J. H., Eastern Nazarene College, Wallaston, Mass.
SHRODE, R. R., Genetics Dept., Texas A & M College, College Station
SHUART, C. E., Hacienda La Estrella, Aguadulce R of Panama
SIBLEY, J. R., Jersey Milk Service, Spencer, Mass.
SIEGMUND, H. B., Hendler Creamery Co., 1100 E. Baltimore St., Baltimore 2, Md.
SIEGRIST, REV. URBAN J., St. Joseph's College, Collegeville, Ind.
SIMONSON, O. J., Oregon Dairy Breeders Assoc., Corvallis
SKELTON, F. M., General Ice Cream Corp., 101 Nott Terrace, Schenectady 1, N. Y.
SKOLE, R. D., 48 Onoto St., Pittsfield, Mass.
SLACK, S. T., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
SLATER, I. W., An. Prod. Dept., Univ. of Wyo., Laramie
SLATTER, W. L., Dept. of Dairy Technol., Ohio State Univ., Columbus
SMITH, A. C., Dept. of An. Ind., Univ. of Conn., Storrs
SMITH, A. D. B., Inst. of Animal Genetics, Kings Bldgs., W. Mains Rd., Edinburgh 9, Scotland
SMITH, C. G., Box 141, Hadley, Mass.
SMITH, C. K., Dept. of Bact. & Pub. Health, Mich. State College, East Lansing
SMITH, D. P., Milprint Inc., W. Depere, Wis.
SMITH, F. R., Pet Milk Co., Greenville, Ill.
SMITH, H. P., 1257 Granville Ave., Chicago
SMITH, J. R., 1300 Rainier Ave., Seattle 44, Wash.
SMITH, J. T., Dept. of Dairy Technol., Ohio State Univ., Columbus
SMITH, R. A., 1417 N. Grand, Pullman, Wash.
SMITH, R. T., 311 Chamber of Commerce, Scranton 3, Pa.
SMITH, V. R., Dept. of Dairy Husb., Univ. of Wis., Madison
SMITH, W. R., Dept. of Dairy Sci., Univ. of Ill., Urbana
SNYDER, V. P., 16231 Emerald Ave., Harvey, Ill.
SNYDER, W. E., The Borden Co., 3638 N. Broadway, Chicago 13
SNYDER, W. W., Dairy Dept., Mich. State College, East Lansing
SOLTZ, L. J., 51 Indianwood Blvd., Park Forest, Ill.
SOMMER, W. A., The Borden Co., Elgin, Ill.
SORENSEN, N. J., College Station, Berrien Springs, Mich.
SORENSON, C. M., 752 Vandalia St., St. Paul 4, Minn.
SORENSON, E. M., Box 289, Chehallis, Wash.
SOTOLA, JERRY, 8901 S. Euclid Ave., Chicago
SOUTHWELL, B. L., Ga. Coastal Plain Expt. Sta., Tifton
SPALDING, R. W., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
SPECK, M. L., Dept. An. Ind., N. C. State College, Raleigh
SPERRY, G. D., Kelco Co., 530 Broadway, San Diego 1, Calif.
SPIELMAN, ARLESS, Dept. of An. Ind., Univ. of Conn., Storrs
SPITZER, R. R., Murphy Products Co., Burlington, Wis.
SPRAGUE, G. W., 935 E. John St., Appleton, Wis.
SPROULE, W. H., Dairy Dept., Ontario Agr. College, Guelph, Ontario, Canada
SPROWLS, R. G., Dept. of Dairy Husb., Ore. State College, Corvallis
SPURGEON, K. R., The Wander Co., Villa Park, Ill.
SQUIBB, R. L., Office Foreign Agr. Relations, U.S.D.A., Washington 25, D. C.
STABILE, J. N., First Army Area Medical Labs., 90 Church St., New York
STAHL, R. T., 1579 Foeller Dr., Green Bay, Wis.
STALLARD, J. E., Dept. of Dairy Husb., Univ. of Wis., Madison 6
STALLCUP, O. T., An. Ind. Dept., Univ. of Ark., Fayetteville
STAMBERG, O. E., Consolidated Products Co., 119 N. Washington St., Danville, Ill.
STANFILL, L. C., Route 14, Knoxville, Tenn.
STANNARD, L. W., 903 E. Holston Ave., Johnson City, Tenn.
STARBUCK, R. R., Dairy Husb. Dept., Ohio State Univ., Columbus
STARK, C. N., Middle Tenn. State College, Murfreesboro
STARR, A. E., Canada Packers Ltd., 60 Paton Rd., Toronto, Ont., Canada
STAVER, H. B., Colo. Dept. of Agr., 3130 Zuni St., Denver 11
STEBNITZ, V. C., Chicago Dairy & Food Labs., 6930 N. Clark St., Chicago
STEIN, BRUNO, Shorewood Hills, Madison, Wis.
STEINER, JOHN, Akron Pure Milk Co., 273 W. Bowery St., Akron 8, Ohio
STEVENS, K. M., 121-123 Randolph St., N. Abington, Mass.
STEVENSON, F. G., Southern Ill. Breeding Assoc., Breese, Ill.
STEWART, A. P., Jr., Golden State Co., 58 Sutter St., San Francisco, Calif.
STEWART, K. W., Patton Creamery Co., 809 N. Campbell, Springfield, Mo.
STEWART, R. D., Peterborough, N. H.
STINE, J. B., Kraft Foods Co., 923 Waukegan Rd., Glenview, Ill.
STINNETT, L. H., Dept. of Dairying, Okla. A & M College, Stillwater
STITTS, T. G., H. P. Hood & Sons, 500 Rutherford Ave., Boston 29, Mass.
STOCKING, J. A., Star Route, Roberts, Idaho
STODDARD, G. E., Dept. of Dairy Ind., Utah State Agr. College, Logan

STOLEN, INGMAN, 518 Blackhawk Ave., Madison, Wis.
STONAKER, H. H., An. Husb. Dept., Colo. A & M College, Fort Collins
STONE, E. J., N. La. Hill Farm Expt. Sta., Homer, La.
STONE, J. B., Borden's Dairy Delivery Co., San Francisco 19, Calif.
STONE, W. K., Deyo Ave., Brookfield, Ill.
STORRS, A. B., Palos Heights, Ill.
STOUT, J. L., The Borden Co., 415 N St., Lafayette, Ind.
STOY, C. O., Dade County Health Unit, 800 Court House, Miami, Fla.
STRAHLER, R. C., 7017 Hoover Ave., Dayton 7, Ohio
STRAIT, HOWARD, 501 Walker St., Sturgis, Mich.
STRATTON, J. W., 5 Bentwood St., Greenville, S. C.
STRICKLER, R. E., 225 Anglo Bank Bldg., Fresno, Calif.
STRIFFLER, I. A., The Nestle Co. Inc., Marysville, Ohio
STROBEL, D. R., 1322 Slade Court, Falls Church, Va.
STRYNADKA, N. J., Dairy Produce, 10347 97th St., Edmonton, Alberta, Canada
STUCKEMAN, H. W., Box 164, Kinsman, Ohio
STULL, J. W., Dept. of Dairy Husb., Univ. of Ariz., Tucson
SUMME, J. J., 224 E. 20th St., Covington, Ky.
SUTTON, T. S., College of Agr., Ohio State Univ., Columbus
SWANNER, R. O., N. Y. State Dept. of Health, 203 Empire Theater Bldg., Glens Falls
SWANSON, A. M., Dairy and Food Ind. Dept., Univ. of Wis., Madison
SWANSON, E. W., Dairy Dept., Univ. of Tenn., Knoxville
SWANSON, W. J., Distillation Products Inc., Div. Eastman Kodak Co., Rochester 3, N. Y.
SWEETING, BERT, Medosweet Dairies, Tacoma, Wash.
SWEETMAN, W. J., Alaska Agr. Expt. Sta., Palmer
SWETT, C. R., National Wax Co., 1300 W. Division St., Chicago 22
SWETT, W. W., Bureau of Dairy Industry, Beltsville, Md.
SWOPE, W. D., 122 Sparks St., State College, Pa.
SYKES, J. F., Bureau of Dairy Industry, Beltsville, Md.

TAMSMA, A. F., Dept. of Dairy Ind., Univ. of Calif., Davis
TANABE, T. Y., Dept. of Dairy Husb., Pa. State Univ., State College
TARASSUK, N. P., Dairy Ind. Dept., Univ. of Calif., Davis
TARKOW, LEONARD, 427 W. National Ave., Milwaukee 4, Wis.
TAUB, JOEL, 40 E. 17th St., Brooklyn 26, N. Y.
TAYLOR, J. S., Dept. of Dairy Husb., Pa. State Univ., State College
TAYLOR, N. E., 411 Battery St., San Francisco 26, Calif.
TELFORD, H. R., 841 Cross St., Tulare, Calif.
TEMPLETON, H. L., 6125 Florence Blvd., Omaha 11, Neb.
THACKER, D. L., Carnation Milk Farms, Carnation, Wash.
THEW, H. E., Madison Milk Prod. Assoc., 29 Coyne Ct., Madison, Wis.
THIBODEAU, RICHARD, Cooperative Agricole de Granby, Granby, Quebec, Canada
THOELE, H. W., Dept. of Dairy Husb., Univ. of Minn., St. Paul
THOMAS, ALAN, Dept. of Dairy Husb., Univ. of Minn., St. Paul
THOMAS, B. H., Chemistry Dept., Iowa State College, Ames
THOMAS, D. S., 414 Linwood Ave., Ridgewood, N. J.
THOMAS, ELMER, Dept. Dairy Husb., Univ. of Minn., St. Paul 1
THOMAS, HUGH, 4214 Major Ave., Madison 4, Wis.
THOMAS, J. W., Bureau of Dairy Industry, Beltsville, Md.
THOMAS, R. C., Vet. Sci. Dept., Univ. of Calif., Davis
THOMAS, R. H., Dept. of Dairy Husb., Univ. of Neb., Lincoln
THOMAS, R. O., 118 Mount St., Jackson, Tenn.
THOMPSON, D. I., Verona, Wis.
THOMPSON, E. C., 1792 E. 22nd St., Brooklyn, N. Y.
THOMPSON, G. W., Box 303, Clarion, Pa.
THOMPSON, J. C., Ralston Purina Co., St. Louis 2, Mo.
THOMPSON, N. R., Dairy Husb. Dept., Va. Polytechnic Inst., Blacksburg
THOMSEN, L. C., Dept. of Dairy & Food Ind., Univ. of Wis., Madison
THORNTON, H. R., Dept. of Dairy Husb., Univ. of Alberta, Edmonton, Alberta, Canada
TIBBITS, C. B., 4892 Sunbury Rd., Gahanna, Ohio
TITTSLER, R. P., Bureau of Dairy Industry, Washington 25, D. C.
TITUS, H. W., Lime Crest Research Laboratory, Route 1, Newton, N. J.
TJARKS, E. A., One Gamecock Lane, Babylon, N. Y.
TOBIAS, JOSEPH, Dept. of Food Technol., Univ. of Ill., Urbana
TODD, A. W., 112 Via Ithaca, Newport Beach, Calif.
TOLLENAAR, IR F. D., Central Institute for Nutrition, Research T.N.O., Catharijnesingel 61, Utrecht, The Netherlands
TOOLEY, H. C., Dept. of Health, Pittsfield, Mass.
TOUCHBERRY, R. W., Dept. of Dairy Sci., Univ. of Ill., Urbana
TOWNSEND, E. C., P.O. Box 532, Ripon, Calif.
TRACY, P. H., Dept. of Food Technol., Univ. of Ill., Urbana
TRAISMAN, EDWIN, Route 1, DesPlaines, Ill.
TRANMAL, HENRY, 802 E. Bonneville Ave., Las Vegas, Nev.
TREBILCOCK, R. [illegible], Corn Products Sales Co., 17 Battery Place, New York 4
TREBLER, H. A., 14 E. Chase St., Baltimore 2, Md.
TREGURTHA, J. D., Newark Milk & Cream Co., 26 Bridge St., Newark, N. J.
TRELOGAN, H. C., 6025 N. 18th St., Arlington, Va.
TRETSVEN, J. O., Dept. of Dairy Ind., Mont. State College, Bozeman
TRIMBLE, J. M., Lebanon, Ind.
TRIMBURGER, G. W., An. Husb. Dept., Cornell Univ., Ithaca, N. Y.
TRISH, K. A., 7722 6th Ave., Kenosha, Wis.
TROUT, G. M., Dairy Dept., Mich. State College, East Lansing
TROUTMAN, E. C., 104 Hiltonia Park, Lexington, Ky.

TRYGGESETH, O. A., Muskee Land Dairy, Park Falls, Wis.
TUCKER, HUBERT, 8 E. Long St., Columbus 15, Ohio
TUCKER, W. S., 5015 Monroe St., Toledo, Ohio
TUCKEY, S. L., Dept. of Food Technol., Univ. of Ill., Urbana
TURK, K. L., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
TURNBOW, G. D., 1106 Broadway, Oakland 7, Calif.
TURNER, CHARLES W., Dept. of Dairy Husb., Univ. of Mo., Columbia
TURNER, CLIFTON W., R. D., Timberline Dr., Willoughby, Ohio
TURNER, H. G., Sheffield Farms Co., 1267 6th Ave., New York 19
TURNHAM, P. B., Dept. of Dairy Husb., Ala. Polytechnic Inst., Auburn
TWOROGER, GEORGE, Box Q, Miami 38, Fla.
TYLER, W. J., Dairy Husb. Dept., Univ. of Wis., Madison
TYZNIK, W. J., Dept. of An. Sci., Ohio State Univ., Columbus

ULLAH, SANA, Punjab Agr. College, Lyallpur, West Pakistan
ULVIN, G. B., 1733 Sefa Circle W, Jacksonville, Fla.
UNDERJERG, G. K. L., Dept. of Physiol., Kan. State College, Manhattan
USELMAN, W. E., 345 Sheboygan St., Fond du Lac, Wis.

VALTEICH, H. W., Best Foods Co., 99 Ave. A., Bayonne, N. J.
VANDEMARK, N. L., Dept. of Dairy Sci., Univ. of Ill., Urbana
VANDERBEEK, J. L., 4601 W. 87th St., Oak Lawn, Ill.
VAN DER ZANT, C. W., Dairy Husb., Dept., Texas A & M College, College Station
VAN DYKE, C. W., 11751 Exeter Ave. N.E., Seattle 55, Wash.
VAN KREVELD, A., Cooperative Condensfabried, Friesland, Leeuwarden, Netherlands
VANO, DAVID, 41 Canada Live Bldg., Calgary, Alberta, Canada
VAN PELT, M. D., Box 128, Kindechook, N. Y.
VAN POUCKE, R. F., 614 E. Roosevelt St., Appleton, Wis.
VAN SANT, W. R., Dairy Husb. Dept., Univ. of Ariz., Tucson
VAN WART, R. K., Laurel Ave., East Islip, N. Y.
VARGAS, LUIS, Carrera 6a No. 15-34, Bogota, Colombia, S. A.
VARNEY, BRUCE, 127 W. 10th S., Kansas City, Mo.
VEDEJS, LEON, Joppe's Dairy Co., 900 S. Division Ave., Grand Rapids, Mich.
VERGERONT, O. W., Dairy Husb. Dept., Univ. of Wis., Madison
VERMA, I. S., Lincoln Univ., Jefferson City 1, Mo.
VERNON, E. H., Iberia Livestock Expt. Farm, Jeanerette, La.
VIGUE, R. F., 26 Ellsworth St., Springvale, Maine
VISEK, W. J., 825 E. 60th St., Chicago 37
VOELKER, D. E., An. Husb. Dept., Iowa State College, Ames
VOGELGESANG, C. W., Acme Dairy Products Co., 1209 Lincoln Way E., Massillon, Ohio
VON DOHLEN TIEDEMAN, W., School of Pub. Health, Univ. of Mich., Ann Arbor
VORHES, C. A., 160 Menard St., Chicago 44
VORPERIAN, J. H., 117-01 Park Lane S., Kew Gardens, L. I., N. Y.
VROMAN, H. S., Defiance Milk Prod. Co., Defiance, Ohio

WAGENAAR, RAPHAEL, Food Research Inst., Univ. of Chicago, Chicago 37
WAGGONER, R. W., Box 333, Klamath Falls, Ore.
WAGNER, E. M., 2319 Valley Rd., Harrisburg, Pa.
WAINESS, HAROLD, 228 N. LaSalle St., Chicago 1
WAKEMAN, A. N., Lake Mills, Wis.
WALDO, D. R., Ione, Wash.
WALLACE, A. E., 638 S. Lake St., Neenah, Wis.
WALLACE, H. D., Dept. of An. Husb. & Nutr., Univ. of Fla., Gainesville
WALLENFELDT, EVERT, Dept. of Dairy Ind., Univ. of Wis., Madison
WALLER, E. F., Dept. of An. & Poultry Ind., Univ. of Del., Newark
WALLIS, G. C., Standard Brands Inc., 595 Madison Ave., New York 22
WALSH, T. J., Jr., 28 Atterbury Ave., Trenton 8, N. J.
WALTER, W. G., Dept. of Botany & Bact., Mont. State College, Bozeman
WALTS, C. C., H. P. Hood & Son, 65 Roland St., Boston 29, Mass.
WARD, F. C., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
WARD, GEORGE M., Dairy Dept., Mich. State College, East Lansing
WARD, GERALD M., An. Husb. Dept., Colo. A & M College, Fort Collins
WARD, R. E., Eastern States Farmer Exchange Inc., West Springfield, Mass.
WARNER, R. A., 1606 S. 3rd, Monroe, La.
WARNER, R. G., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
WARREN, F. G., Dept. of An. Ind., N. C. State College, Raleigh
WASSON, A. J., 2413 Leavenworth St., Omaha 5, Neb.
WASSON, F. C., Dept. of Agr., Victoria, B. C., Canada
WATERS, HOWARD, Danville, Iowa
WATSON, J. G., New England Homestead, Springfield, Mass.
WATTON, A. M., February Hill Farm, R. D. Chalfont, Bucks City, Pa.
WATTS, M. W., Allied Mills Inc., Libertyville, Ill.
WAUGH, R. K., Dept. of An. Ind., N. C. State College, Raleigh
WAY, H. O., 2403 Prospect, Cleveland 15, Ohio
WAYMAN, OLIVER, Univ. of Hawaii, Honolulu 14
WAYNE, R. W., 2160 Carter Ave., St. Paul 8, Minn.
WEAR, J. M., Ralston Purina Co., Checkerboard Square, St. Louis 2, Mo.
WEATHERBY, E. J., 2507 Plyers Mill Rd., Silver Spring, Md.
WEAVER, EARL, Dairy Dept., Mich. State College, East Lansing
WEAVER, H. M., Remington, Va.
WEBB, B. H., Natl. Dairy Research Labs., Oakdale, L. I., N. Y.
WEBB, W. B., Jr., 35 E. Gay St., Columbus, Ohio
WEBER, D. K., Mich. Ave. Sta., Lansing 11, Mich.
WEBSTER, H. G., 90 Perry St., Woodstock, Ontario, Canada

WECKEL, K. G., Dept. of Dairy & Food Ind., Univ. of Wis., Madison
WEDEEN, M. M., 115 Jackson Ave., Schenectady, N. Y.
WEEKS, N. S., 402 E. Myrtle St., Hanford, Calif.
WEESE, S. J., Dept. of Dairy Husb., W. Va. Univ., Morgantown
WEETH, H. J., An. Husb. Dept., Univ. of Hawaii, Honolulu 14
WEGERMANN, E. H., 864 18th St. S.E., Cedar Rapids, Iowa
WEIKER, BRYCE, Northern Ohio Breeders Assoc., Tiffin, Ohio
WEINBERGER, R. I., 951 Carroll St., Brooklyn 25, N. Y.
WEINER, L. H., The Borden Co., 3638 Broadway, Chicago 13
WEINREICH, C. F., Cherry-Burrell Corp., 427 W. Randolph St., Chicago 6
WEINSTEIN, BERNARD, Crest Foods Co., Ashton, Ill.
WEIR, G. L., 622 Franklin St., Downers Grove, Ill.
WEISER, H. H., Dept. of Bact., Ohio State Univ., Columbus
WEISKITTEL, W. A., Goshen Milk Cond. Co., Goshen, Ind.
WEISSMAN, HARRY, U. S. Penitentiary, Atlanta, Ga.
WELCH, R. C., Wilbur-Suchard Chocolate Co., Lititz, Pa.
WELKER, R. M., Route 4, Ithaca, N. Y.
WELLS, BERT, Coca-Cola Co., 310 N Ave., N.W., Atlanta, Ga.
WELLS, C. B., Jr., Pet Dairy Products Co., Johnson City, Tenn.
WELLS, R. E., Box 408, Huntington, W. Va.
WELSH, MARK, Lederle Labs, Pearl River, N. Y.
WENTWORTH, W. A., The Borden Co., 350 Madison Ave., New York 17
WERBIN, S. J., Stein Hall & Co. Inc., 285 Madison Ave., New York
WERLING, W. H., Mead Johnson & Co., Evansville 21, Ind.
WERNER, G. M., Dairy Husb. Dept., Univ. of Wis., Madison
WEST, G. A., 1785 Penfield Rd., Penfield, N. Y.
WESTER, KARL, 1127 Burnett Ave., Ames, Iowa
WHEELER, G. C., Route 2, Saludai, S. C.
WHITAKER, R., Natl Dairy Research Labs., Oakdale, L. I., N. Y.
WHITE, A. H., Div. of Bact. & Dairy Research, Science Service Bldg., Ottawa, Ontario, Canada
WHITE, J. C., Dept. of Dairy Ind., Cornell Univ., Ithaca, N. Y.
WHITMAN, D. W., Box 16, University Sta., Urbana, Ill.
WHITMORE, R. E., Mitchell, Neb.
WHITNAH, C. H., Dept. of Chem., Kan. State College, Manhattan
WHITNEY, R. McL., Dept. of Food Technol., Univ. of Ill., Urbana
WHITNEY, W. O., 1243 W. Washington Blvd., Chicago
WHITTIER, E. O., Bureau of Dairy Industry, Washington 25, D. C.
WHITTON, WILLIAM, 3429 N. Figueroa St., Los Angeles 65, Calif.
WIEDEMER, ARTHUR, Route 1, Sharon, Wis.
WIESNER, M. W., Winsted, Minn.
WIGGIN, S. H., Augusta, N. J.
WILBUR, J. W., Dairy Husb. Dept., Purdue Univ., Lafayette, Ind.
WILCOX, D. F., 30 Stetson Ave., Mill Valley, Calif.
WILDASIN, H. L., Whiting Milk Co., 40 Cambridge St., Charlestown, Mass.
WILDE, H. G., Highlawn Farm, Lenox, Mass.
WILEY, T. E., Dept. of An. Husb., Cornell Univ., Ithaca, N. Y.
WILKOWSKE, H. H., Dairy Sci. Dept., Univ. of Fla., Gainesville
WILL, L. J., American Dairy Assoc., 20 N. Wacker Dr., Chicago 6
WILLARD, H. S., American Embassy, Ammon, Jordan, Dept. of State, Washington 25, D. C.
WILLETT, E. L., Found. for the Study of Genetics, Route 5, Madison, Wis.
WILLIAMS, G. A., Dept. of Dairy Husb., Purdue Univ., Lafayette, Ind.
WILLIAMS, J. B., Kraft Foods Co., Corinth, Miss.
WILLIAMS, JESSE B., Dept. of Dairy Husb., N. D. Agr. College, Fargo
WILLIAMS, L. W., Imperial Ice Cream Co., Huntington, W. Va.
WILLIAMS, P. S., Dairy Husb. Dept., Pa. State Univ., State College
WILLINGHAM, J. J., Dept. of Dairy Mfg., Texas Tech. College, Lubbock
WILLIS, L. O., Route 1, Mohnton, Pa.
WILLMANN, JOSEPH, Derby, Conn.
WILSON, CHASE, Dairy Dept., S. D. State College, College Station
WILSON, H. K., 330 E. Paint St., Washington C. H., Ohio
WILSON, H. L., Kraft Cheese Co., 500 Peshtigo Ct., Chicago 90
WILSON, J. L., 108 Ichabod Place, Falls Church, Va.
WILSON, J. L., Economics Laboratory Inc., 914 Guardian Bldg., St. Paul 1, Minn.
WILSON, L. T., Honeggers & Co., Fairbury, Ill.
WILSTER, G. H., Dept. of Dairy Husb., Ore. State College, Corvallis
WINDER, W. C., Dept. of Dairy and Food Ind., Univ. of Wis., Madison
WINDHAM, E. S., 1508 Hanby St., Silver Spring, Md.
WINRIGHT, G. L., Agr. Ext. Service, Court House, El Centro, Calif.
WISE, G. H., Dept. of An. Ind., N. C. State College, Raleigh
WISEMAN, H. G., Bureau of Dairy Industry, Washington 25, D. C.
WOEBKENBERG, NORBERT, H. Woebkenberg Dairy, 15 Voorhees St., Reading, Ohio
WOELFFER, E. A., 115 Woodland Lane, Oconomowoc, Wis.
WOLBERG, F. B., Dairy Husb. Dept., Ore. State College, Corvallis
WOOD, G. R., 555 Homer St., Vancouver 3, B. C., Canada
WOODRUFF, A. C., 324 Spring Valley Rd., Springfield, Pa.
WOODWARD, H. B., 4219 N. 23rd Ave., Phoenix, Ariz.
WOODYARD, O. W., Cudahy Packing Co., Washington C.H., Ohio
WOOLSEY, J. H., 1918 Russell Ave., Santa Rosa, Calif.
WORK, S. H., 1325 C St. S.W., F.A.O. of the U.N., Washington 25, D. C.
WORNICK, R. C., 3606 Wabash Ave., Terre Haute, Ind.
WRIGHT, D. A., White Oak Dairy, Covington, Va.
WRIGHT, E. M., Route 4, Waterloo, Iowa

WRIGHT, FRANK, Dept. of Dairy Ind., Rutgers Univ., New Brunswick, N. J.
WRIGHT, J. H., Pet Milk Co., Greenville, Ill.
WYENO, JURO, Japan Dairy Products Assoc. 2, 2-chome, Kanda-Tsukasa-Cho, Chiyoda-ku, Tokyo, Japan
WYLIE, C. E., Dairy Dept., Univ. of Tenn., Knoxville
WYNN, R. L., Dairy Dept., Agr. & Tech. College of N. C., Greensboro

YALE, M. W., Arden Farms Co., Patterson, Calif.
YAPP, W. W., Dept. of Dairy Sci., Univ. of Ill., Urbana
YARNELL, A. R., Yarnell Ice Cream Co., Searcy, Ark.
YATES, C. M., Maxwelton Farm, St. Anne de Bellevue, P. Quebec, Canada
YONGUE, N. E., 4704 45th St. N.W., Washington, D. C.
YOUNG, D. J., Dept. of An. Ind., Univ. of Del., Newark
YOUNG, G. D., JR., 55 Brookside Rd., Orinda, Calif.
YOUNG, J. O., Dept. of Dairy Husb., Ore. State College, Corvallis
YOUNG, K. F., P.O. Box 158, Smith River, Calif.
YOUNG, P. A., Natl. Dairy Products Corp., 260 Madison Ave., New York 16
YSTGAARD, MARTIN, Norges Landbrukshogskold, Meieriinstuttet, Vollebekk, Norway

ZAKARIASEN, B. M., Land o' Lakes Creameries Inc., 2201 Kennedy St. N.E., Minneapolis 13, Minn.
ZALE, E. R., Midwest Dairy Products Corp., 33 S. Clark St., Chicago
ZALETEL, J. H., Lab. Sect., Mercy Hospital, Des Moines, Iowa
ZEHREN, V. L., Dept. of Dairy and Food Ind., Univ. of Wis., Madison
ZEISSIG, ALEXANDER, Merck & Co., Rahway, N. J.
ZELL, FRED, Route 1, Greentown, Ind.
ZIMMERMAN, H. F., 540 N. Lincoln, Hinsdale, Ill.
ZIMMERMAN, H. K., 8015 Van Nuys Blvd., Van Nuys, Calif.
ZIMMERMAN, J. A., Lehighton, Pa.
ZIMMERMAN, P. L., Marathon Corp., Research Lab., Menasha, Wis.

VOLUME XXXVII January, 1954 NUMBER 1

JOURNAL OF DAIRY SCIENCE

ABSTRACTS OF LITERATURE

W. O. Nelson, Abstract Editor

ANIMAL DISEASES

1. The intake and excretion of minerals at parturition as related to the occurrence of parturient paresis in dairy cows. G. M. WARD, T. H. BLOSSER, M. F. ADAMS, Wash. Agr. Expt. Sta., Pullman. Cir., 220. 1953.

An experiment was initiated to study the difference in mineral metabolism between cows which calved normally and cows which subsequently developed milk fever. Measurements were made of the blood levels and the urinary, fecal, and lacteal excretion of calcium, sodium, potassium and chlorides by 16 dairy cows. Eight of these cows were mature Jerseys, of which 3 developed parturient paresis; 4 were primiporous Jerseys; 2 were mature Guernseys; and 2 mature Holsteins. None of the last three groups developed milk fever. This bull. shows in tabular form the data from the above experiment and is a supplement to Tech. Bull. No. 5 (J. Dairy Sci., October 1953).

R. W. Hunt

2. Maggot therapy of actinomycosis. R. J. DICKE, Dept. of Entomol., Univ. of Wis., Madison. J. Econ. Entomol., **46**, 4: 706. 1953.

Maggot therapy was used to arrest actinomycosis (lumpy jaw) in a Guernsey bull. Septic larvae of the blow fly, *Phaenicia sericata* (Meigen) were applied in lots of several thousand to the diseased area. E. H. Fisher

3. Micrococcus pyogenes in bovine milk II. Relationship of shedding characteristics to occurrence of clinical mastitis. O. W. SCHALM and G. M. WOODS, Univ. of Cal., Davis. Am. J. Vet. Research, **14**, 53: 534. 1953.

Studies in two large dairy herds relative to the incidence of *Micrococcus pyogenes* isolated from the udders are reported. It is postulated that the main source of infection with this organism is other infected or shedding mammary glands. Support for this idea is given by reducing the incidence of shedders from 50 to 5% in one herd by segregation and intensive control and therapy.

Penicillin sensitivity of 920 *M. pyogenes* strains was determined. From one herd, 56.4% of the cultures were able to grow on agar containing 1 U per ml., while from the 2nd herd less than 7% grew on agar containing only 0.1 U per ml. In addition 18.1% of the strains from one herd and 1.5% of those from the other grew on agar containing 10 U of penicillin per ml.

Considerable variation was found in monthly herd tests. Some cows shed *M. pyogenes* every test, others only infrequently, and some remained free. Cows free of infection in one lactation were often infected the following lactation, and in many instances persistent shedders in one lactation had following lactations with infrequent shedding. The average incidence in all lactations probably exceeds 50%. A correlation exists between lactation age and high incidence of shedding. More than 50% of the cows in the 3rd and later lactations shed *M. pyogenes* on more than 50% of their tests during the lactation. About 70% of the cows in the 5th and later lactations were above 50% frequency in shedding the organisms. In spite of this high rate of infection the rate of clinical mastitis was only 18.7% in the lactations in which 50% or more of the tests showed *M. pyogenes*. The highest incidence of clinical mastitis was associated with a high frequency of *M. pyogenes* shedding, and only 1 clinical case was observed in 188 lactations with less than 25% of the tests showing *M. pyogenes*. Resistance to the pathogen is undoubtedly developed by most cows, as evident from the relatively low incidence of clinical mastitis and mildness of the attacks in the presence of a high incidence of persistent infections.

E. W. Swanson

4. Laboratory procedures used in the Connecticut mastitis-control program. W. N. PLASTRIDGE, H. H. HALE, L. F. WILLIAMS, C. GOURD, and J. V. SMITH, Storrs (Conn.) Agr. Expt. Sta. Inf., 46. 1952.

The bull. describes the method of collecting samples, staining and counting technique for smears, as well as types of media used and method of incubating and counting plates in this mastitis program. R. W. Hunt

5. Q-fever and its relation to dairy products. J. B. ENRIGHT, R. C. THOMAS, and P. A. MULLETT, Veterinary Pub. Health School,

Univ. of Cal., Davis. J. of Milk and Food Technol., **16**: 263. 1953.

The causative agent of Q-fever, an "inapparent" infection in cattle, sheep and goats, is widely distributed in nature. The disease is infectious for man. Infected animals may eliminate the organisms in their milk which introduces it into the environment of man. Investigations show that causative agent of Q-fever may survive pasteurization of milk, and thus this disease is important from the public health standpoint. H. H. Weiser

6. Calves thrive in portable pens. ANON., Agr. Research, Washington. Supt. of Documents, Govt. Printing Office. Pg. 11. 1953.

Experiments conducted at A.R.A.'s. Animal Disease Lab., Auburn, Ala., indicate calves raised in portable pens are less apt to become invested with parasites than those raised in barns. R. W. Hunt

7. Preventive medicine on the farm. E. G. WHITE, Nature, **172**, 4378: 561. 1953.

A review of a symposium held by the British Association, Section on Agriculture, on Sept. 7, 1953, at Liverpool, on the subject of "Preventive Medicine among Farm Livestock." R. Whitaker

8. A report of the screening of aralen dihydrochloride for activity against Anaplasma marginale. J. G. MILLER, H. E. LEVY, and W. T. OGLESBY, La. State Univ., Baton Rouge. Am. J. Vet. Research, **14**, 53: 517. 1953.

The anti-malarial drug aralen had failed to give expected results in field cases of anaplasmosis in Louisiana, based upon reports of its successful use in Oklahoma. Therefore experiments were made with calves and adult cows to determine the effect of aralen upon the inhibition of the *marginale* bodies in blood cells. No difference between treated and untreated infected animals was found. The course of the disease was not altered in any respect. E. W. Swanson

9. Therapeutic solution of calcium lactate and calcium glycerophosphate. G. SATTLER, JR. and B. SATTLER (assignors to The Carlton Corp.). U. S. Patent 2,657,172. 2 claims. Oct. 27, 1953. Official Gaz. U. S. Pat. Office, **675**, 4: 1092. 1953.

A clear solution, suitable for injecting calcium subcutaneously or intramuscularly, and containing 0.1 to 2.0% of calcium lactate and calcium glycerophosphate, and having a pH of 7.0 to 7.5. R. Whitaker

10. Copper and molybdenum in relation to diseases of cattle and sheep in New Zealand. I. J. CUNNINGHAM, Dept. of Agr., Wallaceville, N. Z. Symposium on Copper Metabolism. Johns Hopkins Press, 246. 1950. (Chem. Abstr., **47**: 11461f. 1953.) B. L. Larson

11. Biochemical studies on an endemic disease known as kuwazu disease in Japan. II. K. IWAMOTO, Shiga Agr. Coll., Shiga Pref. J. Agr. Chem. Soc. Japan, **26**: 553. 1952 (Pub. 1953.). (Chem. Abstr., **47**: 10681b. 1953.) B. L. Larson

BOOK REVIEWS

12. Biochemistry and physiology of nutrition, Vol. I. Edited by GEOFFREY H. BOURNE and GEORGE W. KIDDER, Academic Press Inc., New York, N. Y. 569 pp. $13.00. 1953.

The titles, authors and number of pages devoted to the various chapters follow: The early development of the science of nutrition, by E. P. Catheart, (17); The history of vitamins, by Leslie J. Harris, (22); Water and electrolyte metabolism, by R. L. Zwemer, (19); Carbohydrate metabolism, T. L. Sourkes, (45); Amino acids, by Alton Meister, (85); The biosynthesis of proteins, by Henry Borsook and Clara L. Deasy, (24); Lipid metabolism, A. C. Frazer, (53); The fat-soluble vitamins, by Thomas Moore, (27); The vitamin B complex, by S. K. Kon and J. W. G. Porter, (36); Vitamins and hematopoiesis, by T. H. Jukes, (42); Vitamin C, by B. B. Lloyd and H. M. Sinclair, (103); Author index, (38); and Subject index, (58).

The stated objective of the editors was "to gather together into one work the most salient segments of the vast amount of research dealing with the field of nutrition." It is remarkable how well this objective has been accomplished in certain areas of this volume, in particular chapters on Amino Acids, Biosynthesis of Proteins, and Vitamins and Hematopoiesis. In some cases this has been accomplished by neglecting information of general interest. Many workers might appreciate a more complete treatment of protein-metabolism. The chapter on the B Vitamins seems especially weak. The editors justify this on the basis of coverage in "many recent reviews." An extension of this justification may logically eliminate the need for such a volume entirely. However, the reviewer feels that a better reason for brevity in this chapter is the unavoidable overlapping which would have resulted with other areas in the treatise such as Vitamins and Hematopoiesis and later in Volume II, Coenzymes. Volume I is concluded with a detailed review of Vitamin C. One wonders if space (103 pp.) out of proportion to its importance has not been devoted to this subject. Finally, it is regrettable that the high cost of this well-documented, up-to-date treatise will prevent it from being readily available on the book shelf of many people interested in problems of nutrition. R. G. Hansen

13. The cold chain in the U.S.A. Technical Assistance Mission No. 17. Part I. General Report 1951. Part II. Technical Survey. Or-

ganization for European Economic Cooperation. 1952.

The two volumes constitute the report of a Mission of 50 experts from 12 countries of Western Europe which visited the United States in August and September of 1950 to engage in a survey of refrigeration in relation to the economy of this country. Volume I reviews the employment of refrigeration in food industry (refrigerated transport, storage and distribution). Recent American techniques in the manufacture of equipment are described. One chapter is devoted to the analysis of the economic conditions of the development of refrigeration in the United States. Volume I concludes with a most important series of recommendations on the action to be taken by the various specialists in the sectors concerned: laboratory research, workers, statisticians, constructors of machinery, farmers, transporters, storage departments, etc. Complementary technical recommendations have been added in some chapters of the second part, which comprises the Technical Report of the Mission. The 34 chapters of volume II are grouped under 5 sections as follows: Sec. I. Basic Considerations; Sec. II. Refrigeration Machinery; Sec. III. Refrigerating Plants; Sec. IV. Transport; Sec. V. Refrigeration Applied to Perishable Foods. The survey, while of short duration, accomplished a wide coverage of the place of refrigeration in the economy of the United States because of the fact that the experts in the various fields of refrigeration application and food technology were enabled to concentrate their survey work in their respective specialties. For obtaining a critical and unbiased picture of the importance of refrigeration in the food industries of the United States there is not a single volume of domestic publication to equal The Cold Chain.

L. M. Dorsey

14. Industrial wastes, their disposal and treatment. Edited by WILLEM RUDOLFS, Dept. of Sanitation, Rutgers Univ., New Brunswick, N. J. Reinhold Publishing Corp., 487 pp. 1953.

The various chapters of this book represent the modern views, theories, methods, and applications of waste treatment as seen by the individual collaborators, each a specialist in a particular field. The subjects are treated from the physical, chemical and biochemical aspects, with sufficient engineering features necessary for a comprehensive understanding of industrial installations and their operation in handling specific waste problems. It is a subject matter treatment that should be welcomed by not only the engineer and the chemist directly concerned with waste disposal problems, but by the industrial executives who need to become informed because of the possible major expense impact of the waste disposal problem. Here also is a reference book for the research worker, and an up-to-date textbook for teacher and student in the field of sanitary engineering. It is recommended also as an information source for state and municipal officials called upon to evolve policies of development and control, and for municipal employees charged with treatment of domestic sewage and industrial wastes. Chapter 3, Milk Products Waste, is of direct interest to the processing plant operators of the dairy industry and is written by E. F. Eldrige, Washington State Pollution Commission, who for many years was associated with the Michigan State College Engineering Experiment Station and was a pioneer in the study of dairy waste disposal.

L. M. Dorsey

BUTTER

15. The future of butter. L. P. FREDERICKSON, Director, Federation of Danish Dairy Associations. Milk Products J., **44**, 11: 31. 1953.

The importance of butter production, quantitatively and economically, has been declining over a long period while the production of other edible fats, especially margarine, has increased enormously. This is attributed to the abnormal conditions which have followed two world wars and to various post-war phenomena.

The dairy industry must use modern technical means to the greatest possible extent to improve the quality of butter, to reduce production costs, and to improve the industry's position. Modern and effective sales propaganda also must be developed to use all available possibilities for raising butter consumption so that butter production can again take its traditional place as one of the most important factors in the dairy industry.

J. J. Janzen

16. Prevention of cold-storage defects in butter with antioxidants, especially tetraalkylthiuram disulfides. F. D. TOLLENAAR, Centraal Inst. Boedingsonderzoek, T.N.O., Utrecht, Holland. Centraal Inst. Voedingsonderzoek, T.N.O., Utrecht, Publ. 166, 148 pp. English summary, 133. 1953. (Chem. Abstr., **47**: 12678h. 1953.) S. Patton

17. Intensification of aroma of butter cultures (starter). V. M. BAGDANOV. Molochnaya Prom., **14**, 8: 17. 1953. (Chem. Abstr., **47**: 12678i. 1953.) S. Patton

18. Transformation of the gas phase in salted sour-cream butter during its storage. P. SHEBANIN, S. M. Kirov Agr. Inst., Omsk. Molochnaya Prom., **14**, 8: 36. 1953. (Chem. Abstr., **47**: 12679b. 1953.) S. Patton

19. Production of graded butter in Switzerland. F. LANG, Commonwealth Bur. Dairy Sci., Shinfield, Reading, Engl. Dairy Inds., **18**: 778. 1953. (Chem. Abstr., **47**: 12679d. 1953.) S. Patton

20. From the experimental work on a continuous buttermaking process. N. BABICH, Molochnaya Prom., **14**, 7: 39. 1953. (Chem. Abstr., **47**: 12679e. 1953.) S. Patton

CHEESE

21. Cheddar-cheese flavor and its relation to tyramine production by lactic acid bacteria. J. C. DACRE, Dairy Research Inst., Palmerston North, New Zealand. J. Dairy Res., **20**, 2: 217. 1953.

Experimental cheese made from milk to which cultures of *Streptococcus faecalis*, *Lactobacillus plantarum* or *Leuconostoc sp.* had been added developed the characteristic Cheddar flavor more rapidly than did control cheeses. Increasing tyramine values were found only in the cheeses made with strains of *S. faecalis*. A cheese made with *L. brevis* showed a similar increase in tyramine content but the flavor was abnormal. Thus, the production of tyramine was considered merely incidental to development of Cheddar flavor. A survey of about 100 different strains of lactic acid producing bacteria showed the presence of an L (−) tyrosine decarboxylase only in strains of *L. brevis*.
J. C. Olson, Jr.

22. Studies on a washed curd variety of cheese. II. The influence of variation in the washing and scalding processes. J. WHITMORE, Dairy Dept., University of Reading, Engl. J. Dairy Research, **20**, 2: 212. 1953.

Data are presented relative to the effect of different washing and scalding procedures on the body and texture and on eyehole formation of 83 experimental washed curd cheeses.

A wash in which one-half of the whey was replaced with hot water yielded significantly better results than other washing procedures studied. Good body and texture was favored by low scalding temperatures (98-107° F.) and short scalding times (8-20 min.). Eyehole formation was affected considerably more by scalding time than by temperature, with the most satisfactory results being obtained at scalding times under 30 min. The best combination of conditions appeared to be a "half wash" with scalding at 103° F. for a period not exceeding 25 min.

Results of a study on the effect of size of cheese on the quality of the finished product indicate that the use of larger cheese molds (30 lb.) instead of the original square 12 lb. size is likely to yield an unsatisfactory product.
E. L. Thomas

23. Pumping curd saves labor. ANON. Milk Prod. J., **44**, 12: 30. 1953.

The efficiency of cheese making operations may be increased by pumping curd and whey slurries from vats of cheddar and brick cheese. The curd can be moved efficiently without damaging its physical properties and at the same time greater sanitation is attained.

The use of a single lobe impeller and a speed not exceeding 150 to 160 r.p.m. has been suggested. Univ. of Wis. studies have shown that twin lobe impellers can be used satisfactorily. To keep the curd in a movable, pumpable slurry an amount of whey equal to one-quarter the weight of the original milk is adequate. Pumps available are capable of pumping 60,000 lb. per hr.

Experiments comparing normal curd handling versus pumping did not show any difference in the yields. J. J. Janzen

24. Engineered press simplifies cheese handling. R. R. HAUGH, Q.M. Food & Container Inst., Chicago, Ill. Food Eng., **25**, 11: 88. 1953.

A new all-metal cylindrical cheese press and retaining hoop have been devised to overcome some of the difficulties of handling mammoth cheeses. Cheese is pressed in an upright perforated cylindrical jacket which is later removed. After being paraffined or vacuum bagged, the cheese is placed in a retaining or shipping hoop for curing and handling. The pressing and retaining hoops are about 36 in. high x 21 in. dia. T. J. Claydon

25. Controlling flavor and texture in sweet curd cottage chese. G. D. YOUNG, Dairy Prod. Lab., San Francisco, Cal. Am. Dairy Prod. Rev., **15**, 10: 2. 1953.

The causes and prevention of various flavor and texture defects in cottage cheese are discussed. T. J. Claydon

26. Ripening in cheddar cheese. ANON. Ky. Agr. Expt. Sta., Lexington. 65th Ann. Rept., 40. 1952.

Ten lots of cheese were ripened at the following temperatures: (1) 75° F. for 3 wks., then 40° F. for 9 wks.; (2) 75° F. for 6 wks., then 40° F. for 6 wks.; (3) 50° F. for 12 wks.; (4) 40° F. for 6 wks., then 75° F. for 6 wks.; (5) 40° F. for 9 wks., then 75° F. for 3 wks.; (6) 80° F. for 3 d., then 12 wks. at 40° F.; (7) 80° F. for 7 d., then 40° F. for 11 wks.; (8) 80° F. for 10 d., then 40° F. for 11 wks. Most rapid development of flavor was obtained by (2) and (4), whereas (7) and (8) were slowest; (2) and (4) were considered to possess unsatisfactory flavor, with (3) and (8) having the most desirable type of flavor.
R. W. Hunt

27. Manufacture of cheese. C. ARKIN. U. S. Patent 2,657,993. 12 claims. Nov. 3, 1953. Official Gaz. U. S. Pat. Office, **676**, 1: 239. 1953.

A continuous method for the manufacture of cheese, which comprises of inoculating milk with a starter and coagulant, allowing the milk

to coagulate, cutting the curd, draining the whey, raising the temperature, homogenizing and forming into shapes and sizes suitable for maturing. R. Whitaker

28. Cheese making method. R. Miollis (assignor to The Borden Co.). U. S. Patent 2,657,994. 5 claims. Nov. 3, 1953. Official Gaz. U. S. Pat. Office, **676**, 1: 240. 1953.

Similar to U. S. Patent 2,654, 151. See Abstr. No. 972, Nov. 1953. R. Whitaker

29. Cheese slicer. J. B. Taylor. U. S. Patent 2,656,602. 4 claims. Oct. 27, 1953. Official Gaz. U. S. Pat. Office, **675**, 4: 931. 1953.

A device for slicing cheese, consisting of a base and a frame for holding a taut wire. R. Whitaker

30. Cheese cutter. S. Kaplan and B. Platts. U. S. Patent 2,658,275. 2 claims. Nov. 10, 1953. Official Gaz. U. S. Pat. Office, **676**, 2: 374. 1953.

A rectangular block of cheese is placed on a frame and sliced into individual servings by pressing an arm holding a series of taut parallel cutting wires down through the cheese. The arm is hinged to the frame in a fixed position, so that the wires enter slots in the base frame. R. Whitaker

31. The humidity of air and the distribution of salt in Dutch cheese. A. Makar'in. Molochnaya Prom., **14**, 7: 34. 1953. (Chem. Abstr., **47**: 12680b. 1953.) S. Patton

32. Elimination of flavor defect of cheese classified as bitter flavor. E. Konopleva. Molochnaya Prom., **14**, 7: 27. 1953. (Chem. Abstr., **47**: 12680c. 1953.) S. Patton

33. Special features in the manufacture of curds (soft cheese) in all-metal equipped plant. N. Mazokhina, Molochnaya Prom., **14**, 6: 21. 1953. (Chem. Abstr., **47**: 10759f. 1953.) S. Patton

CONDENSED AND DRIED MILKS; BY-PRODUCTS

34. The role of concentrated milk proteins in the dairy industry. E. C. Scott, Crest Foods Co., Ashton, Ill. Proc. of the 22nd Ann. State Coll. of Wash. Inst. of Dairying, Pullman. 47. 1953.

A soluble concentrated whole milk protein fusion product recently developed has found application in frozen desserts, diatetic or diabetic ice cream and ice milk, high protein-low calorie ice milk, low fat milk shake base, half and half homogenized milk, skimmilk and whipping cream.

The product is said to be bland and pleasant to the taste and to serve both a nutritional and functional purpose. J. Tobias

35. Stabilized lactic casein solution. K. B. Daniloff (assignor to Monsanto Chemical Co.). U. S. Patent 2,662,026. 9 claims. Dec. 8, 1953. Official Gaz. U. S. Pat. Office, **677**, 2: 490. 1953.

A casein base emulsion paste paint is made from 20 to 60 parts lactic casein soln., 4.3 parts drying oil, 2 parts NH_3 soap, 9.6 parts mineral pigment and 46.4 parts of mineral filler. The casein soln. is made by blending 100 parts casein freed from proteolytic enzymes by heating a 10 to 30% soln. 10 to 30 minutes at 150 to 170° F., with 10 to 40 parts borax, 2.5 and 10 parts borie acid, 1 to 5 parts Na salt of mono-chlor-phenylphenol and .25 to 1 part of Na pentachlorphenate. R. Whitaker

36. Centrifugal atomizer. D. D. Peebles and C. P. Turner (assignors to Western Condensing Co.). U. S. Patent 2,661,984. 3 claims. Dec. 8, 1953. Official Gaz. U. S. Pat. Office, **677**, 2: 480. 1953.

A centrifugal disc type of atomizer is described for use with a spray drier for milk, whey, etc. R. Whitaker

37. Whey products and process of manufacture. L. H. Francis and N. E. Rodgers (assignors to Western Condensing Co.). U. S. Patent 2,661,295. 4 claims. Dec. 1, 1953. Official Gaz. U. S. Pat. Office, **677**, 1: 215. 1953.

A pelletized dried whey product, containing no binder, is produced by concentrating and drying whey to form a moist powder containing from 6 to 10% moisture. The powdered material is then pressed into pellets at a temperature of 90 to 130° F. and hardened in a stream of cool air. The moisture content is then reduced further by drying in air at 90 to 170° F. R. Whitaker

38. Method of drying lacteal fluids. R. E. Meade (assignor to Western Condensing Co.). U. S. Patent 2,661,294. 8 claims. Dec. 1, 1953. Official Gaz. U. S. Pat. Office, **677**, 1: 215. 1953.

Liquid whey first is concentrated and at least 50% of the lactose is allowed to crystallize as the monohydrate. The resulting suspension is spray dried to form a nonhydroscopic food product. R. Whitaker

39. Milk can container. C. C. Crippen. U. S. Patent 2,657,828. 11 claims. Nov. 3, 1953. Official Gaz. U. S. Pat. Office, **676**, 1: 194. 1953.

A receptacle having an artistic shape and contour, with a handle and pouring spout for dispensing evaporated milk. The can of evaporated milk is placed on a platform within the receptacle. When the cover is closed, a sharpened tube leading to the pouring spout, pierces the top of the can on one side, while another sharpened tube pierces the top on the opposite

side and acts as an air vent. Both tubes can be closed by manipulating a lever located adjacent to the handle of the receptacle.
R. Whitaker

40. Infant food. H. W. Howard and J. F. Muller (assignors to The Borden Co.). U. S. Patent 2,659,676. 3 claims. Nov. 17, 1953. Official Gaz. U. S. Pat. Office, **676**, 3: 837. 1953.

An infant food containing lactose, fat and edible protein, with not less than 50% of the fat as palm oil and less subject to oxidation than milk fat. R. Whitaker

41. The influence of dispersion (the particle size) of dried milk on its stability. N. Panasenkov and V. Boitsun, S. M. Kirov Agr. Inst., Omsk. Molochnaya Prom., **14**, 7: 30. 1953. (Chem. Abstr., **47**: 12676b. 1953.)
S. Patton

42. Substitutes for hen albumin from whey. Nederlandsche Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek. S. G. Wiechers, inventor. Dutch 72,058, Apr. 15, 1953. (Chem. Abstr., **47**: 12697h. 1953.)
S. Patton

43. A new method for obtaining edible milk albumin. P. F. Dlyachenko, All-Union Sci. Research Inst. Dairy Ind., Moscow. Voprosy Pitaniya, **12**, 3: 65. 1953. (Chem. Abstr., **47**: 11585f. 1953.) S. Patton

44. Powdered lactic acid beverage. T. Maeda, Japan. 5433 ('52), Dec. 23. (Chem. Abstr., **47**: 11599g. 1953.) S. Patton

45. Foamy beverages. C. Hesse, Ger. 811,071, Aug. 16, 1951. (Chem. Abstr., **47**: 11599g. 1953.) S. Patton

46. Edible whips. J. Fleischhacker, Austrian 176,105, Sept. 25, 1953. (Chem. Abstr., **47**: 11600a. 1953.) S. Patton

47. Antioxygenic action of vitamin C on the constituents of dried whole milk. I. Effect of hydroquinone and cisisosafroeugenol. T. Nakanishi, J. Kuroda, T. Kawanami, and S. Adachi, Yohoku Univ., Sendai. Tokoku J. Agr. Research, **3**: 113. 1952. (Chem. Abstr., **47**: 10756a. 1953.) S. Patton

DAIRY BACTERIOLOGY

48. A method for direct viable counts of the facultatively anaerobic microflora in the rumen of a sheep maintained on a hay diet. P. J. Heald, N. Krogh, S. O. Mann, J. C. Appleby, F. M. Masson, and A. E. Oxford, Rowett Research Inst., Bucksburn, Aberdeenshire. J. Gen. Microbiol., **9**, 2: 207. 1953.

An agar medium consisting of buffered and clarified rumen liquor, supplemented with vitamin-free acid hydrolysate of casein, tryptophane, and a fermentable carbohydrate was used in deep culture to cultivate the facultative anaerobes present in the rumen contents of an hay-fed sheep. Counts of 10^9 per g., consisting mostly of gram positive cocci capable of fermenting a variety of carbohydrates, were obtained. Mannitol-fermenting organisms, mostly gram negative rods, were obtained in numbers of about 10^6 per g. J. J. Jezeski

49. The classification of lactobacilli by means of physiological tests. M. Briggs, Natl. Inst. for Research in Dairying, Univ. of Reading, Engl., J. Gen. Microbiol., **9**, 2: 234. 1953.

The tests consisted of the following: production of gas from glucose and citrate, the production of ammonia from arginine, growth at 15, 45, and 48° C., heat survival at 60 and 65° C., and growth tolerance of 4, 6 and 8% sodium chloride. The stock cultures were carried on yeast-glucose-litmus milk plus chalk, and the basal medium of the cultural tests consisted of tomato juice-glucose broth. The cultures tested included 452 strains of lactobacilli representative of most well recognized species and 197 freshly isolated cultures. On the basis of the results of these tests, 86% or 390 cultures were classified into 8 groups.
J. J. Jezeski

50. The keeping quality of pasteurized milk as influenced by the growth of psychrophilic bacteria and the addition of aureomycin. J. C. Olson, Jr., D. S. Willoughby, E. L. Thomas, and H. H. Morris, Dept. of Dairy Husb., Univ. of Minn., St. Paul. J. of Milk and Food Technol., **16**, 5: 213. 1953.

The majority of psychrophilic bacteria can be eliminated in market milk by proper cleaning and bactericidal treatment of all post-pasteurization equipment, including bottles. The presence of psychrophiles in fresh milk has no relationship to keeping quality unless an unusually large quantity of milk has been examined. Individual plants vary widely in regard to the presence of these bacteria in their products.

The addition of 0.2 γ of aureomycin per ml. of milk had no effect on the keeping quality of pasteurized milk. Proper pasteurization is a good means for controlling psychrophilic bacteria in milk. H. H. Weiser

51. Role of calcium and related ions in proliferation of lactic streptococcus bacteriophage. N. N. Potter and F. E. Nelson, Iowa Agr. Expt. Sta., Ames. J. Bacteriol., **66**: 508. 1953.

Ca, which may be replaced by Sr, Ba or Mn ions, is necessary for multiplication of this type of phage. Equimolar concentrations of the latter ions are less effective than Ca. Mg

and Co ions were not effective themselves, but were stimulatory when combined with low levels of Ca; apparently this is due to a sparing action toward Ca. These ions are not necessary for adsorption or for the later stages of multiplication. They apparently function in bacteriophage penetration into host cells or steps leading to penetration after adsorption has occurred. F. E. Nelson

52. The nutritional equivalence of pantothenate and p-aminobenzoate for the growth of Bacterium linens. M. Purko, W. O. Nelson, and W. A. Wood, Univ. of Ill., Urbana. J. Bacteriol., **66**: 561. 1953.

One strain (456) requires either pantothenate or *p*-aminobenzoate for growth. Cells grown in the presence of one of these factors contained the other. Biotin stimulated growth in the presence of either one of these factors and reduced the amounts of them found in the cells. F. E. Nelson

53. The influence of various metabolites upon the p-aminobenzoate-pantothenate interaction in Bacterium linens. M. E. Friedman, W. A. Wood, and W. O. Nelson, Univ. of Ill., Urbana. J. Bacteriol., **66**: 568. 1953.

Either pantothenate or *p*-aminobenzoate was the only single nutrient required. Ammonium ion or a single amino acid was inadequate as a nitrogen source. Rapid growth required a mixture of 16 or more amino acids, salts and either pantothenate or *p*-aminobenzoate.
F. E. Nelson

54. Observations on the serological typing of group N ('lactic') streptococci. C. A. E. Briggs and L. G. M. Newland, Natl. Inst. for Research in Dairying, Univ. of Reading, Engl. J. Dairy Res., **20**, 2: 189-197. 1953.

Agglutinating type sera were prepared in rabbits against 14 heterologous strains of group N streptococci. Nisin-producing strains of *S. lactis* and strains of *S. cremoris* and *S. diacetilactis* each contained a species-specific antigen. None of about 40 non-inhibitory strains, of *S. lactis* or other species, possessed the 'nisin' antigen. In each of the three species some strains possessed additional heterologous antigens whose occurrence was not limited to a single species. Quantitative differences were shown in the representation of certain common antigens, *S. lactis* OJ and *S. cremoris HP* possessing 2 antigens in an inverse proportion of 4:1. The antigen predominating in HP was the common 'cremoris' antigen, whereas the other was apparently limited in occurrence to OJ and HP. The implications of the presence of 'cremoris' antigen in *S. lactis* OJ were discussed.
J. C. Olson, Jr.

55. Bacteriological studies on pasteurized milk. H. Alexander and C. Higginbottom, The Hannah Dairy Research Inst., Kirkhill, Ayr, Scot. J. Dairy Res., **20**, 2: 156. 1953.

Numbers and types of bacteria in raw milk were determined and compared with those surviving commercial HTST or laboratory 'Holder' (LT) pasteurization of the same milk. Colony counts at both 37 and 30° C. indicated greater than 90% destruction of the bacteria by pasteurization, the LT process being slightly more effective than the HTST process. Coliform tests were negative in all 25 LT pasteurized milks. The high percentage of positive tests found in the HTST pasteurized milks was attributed in part to contamination in the cooling section of one pasteurizer.

Keeping quality, as tested by methylene blue reduction, alcohol precipitation and clot-on-boiling, was not significantly different for the two pasteurization processes. High-acid producing streptococci predominated in the raw milks. Pasteurization increased the relative proportions of low-acid producing bacteria to over 90%, at the expense of high-acid producing streptococci and non-acid producing non-spore-forming rods. Of the streptococci, only *S. thermophilus* and occasionally *S. faecalis* survived pasteurization. The proportions of micrococci, microbacteria and spore-forming bacilli increased; the survival of the latter group being estimated as high as 24.5%. For all groups except the micrococci, the percentage of surviving bacteria was greater in the HTST than in the LT pasteurized milk.

Preliminary observations were made of changes during storage of milk pasteurized by both methods. At 18.5° C. the pattern of acidity development varied considerably among the milks, the increase being generally earlier and more rapid in the HTST pasteurized milks. At 6° C. the sharp rise in acidity was noted in both LT and HTST pasteurized milks but was later in onset in the former series. Because of the high frequency of sweet curdling, instability to alcohol or to heat correlated more closely with deterioration in keeping quality than did acid production.

An early overgrowth of alkali-producing and proteolytic bacteria occurred in the milks stored at 18.5° C. While these types frequently were responsible for the deterioration of the samples, they were eventually replaced by the *S. lactis* group of acid-producers. Similar changes took place more slowly at 6° C., but in a few samples *Bacillus circulans* and yeasts predominated.
J. C. Olson, Jr.

56. Rumen microorganisms. Factors influencing protein synthesis by microorganisms in vitro. D. B. Hudman and H. O. Kunkel, with the technical assistance of B. J. Hood, Dept. of Biochemistry and Nutrition and Animal Husbandry, Texas A. & M. Coll., College Station. J. Food Chem., **1**, 17: 1060. 1953.

A number of factors that might influence

the synthesis of protein from nonprotein nitrogen by rumen bacteria were evaluated by using the *in vitro* or "artificial rumen" technique. Protein synthesis was estimated by measuring the tungstic acid-precipitable nitrogen in fermentation flasks containing a total volume of 0.3 l. of inoculum and media. Using a level of 0.6% or more urea or the equivalent in other nitrogen sources, maximum synthesis was often obtained within 3 to 6 hrs. of incubation at 39° C. With low levels of urea, an atmosphere of carbon dioxide was more effective than one of nitrogen, but at the optimum urea concentrations, only anaerobiosis seemed to be necessary. Urea and ammonium acetate were the best nitrogen sources used. The greatest variation in results was due to the level and type of rumen inoculum used. There appeared to be a distinct optimum level of rumen inoculum, below and above which net protein synthesis was decreased. Three g. of glucose plus 9 to 15 g. of cellulose per l. of medium supply the energy required for maximum protein synthesis.
S. Patton

57. The action of hypochlorite and other disinfectants on micrococci with and without milk. J. LASMANIS and G. R. SPENCER, Wash. Agr. Expt. Sta., Pullman. Am. J. Vet. Research, **14**, 53: 514. 1953.

The resistance of 78 strains of micrococci (62 coagulase +) isolated from milk and the environment of dairy cows was tested in Roccal-R and sodium and calcium hypochlorite in the presence of 0.5, 1, 2, and 3% milk. All strains tested were killed at 1:2500 concentration of Roccal in 3% milk, while none were killed in hypochlorite containing 3% milk. There was no difference in resistance of coagulase negative and coagulase positive strains. Sodium hypochlorite was more effective than calcium hypochlorite in the presence of milk. The importance of frequent changes of teat cup disinfecting solution is emphasized by these results.
E. W. Swanson

58. Storage of the bacteriophage of the lactic streptococci in the desiccated state with observations on longevity. C. C. PROUTY, Dept. of Dairy Sci., State Coll. of Wash., Pullman. Appl. Microbiol., **1**, 5: 250. 1953.

A method for the preservation of *S. lactis* and *S. cremoris* bacteriophage is described. Sterile 1 × 4 cm. squares of filter paper saturated with whey filtrate containing high concentrations of the respective viruses were dried at 37° C. from 30 to 60 min. and stored in a screw-cap jar. The desiccated viruses remained viable at 0° C. for 42 mo. and at 37° C. for 72 mo. When held at 12 and 25° C. the viability of the phages was extended to 78 mo.
H. H. Weiser

59. Enhancement of antibiotic production by the use of sea water media. G. J. JANN, H. A. WALCH, and A. J. SALLE, Dept. of Bacteriol., Univ. of Cal., Los Angeles. Appl. Microbiol., **1**, 5: 224. 1953.

Certain trace elements present in sea water play an important role in the production of antibiotic substances by *Streptomyces* and molds. These growth factors are lacking in a medium containing sodium chloride, tap water or distilled water.
H. H. Weiser

60 Micrococcus pyogenes in bovine milk I. Identification. O. W. SCHALIN and G. M. WOODS, Univ. of Cal., Davis. Am. J. Vet. Research, **14**, 53: 530. 1953.

A study has been made of micrococci isolated from udders in two herds free of *S. agalactiae* and from clinical mastitis cases in which micrococci were found. Reactions of the organisms were noted in raw milk (Hotis test), litmus milk, gelatin, blood agar plates, and mannitol salt agar. Wide variations in reactions in these media were observed. It was concluded that the criteria for pathogenicity of the micrococci encountered in the udder are (1) production of beta toxin on agar containing blood capable of demonstrating it, and/or (2) the coagulation of rabbit plasma.
E. W. Swanson

61. Bacteriologische eisen van gesteriliseerde melk (Bacteriological requirements for sterilized milk). English summary. G. TIERIE, Neth. Milk Dairy J., **7**, 3: 138. 1953.

In 1952, 28.8% of all bottled milk sold in the Netherlands was sterilized milk. Deterioration usually was caused by mesophilic bacilli (*B. subtilis* and *B. circulans*). Anaerobic sporeforming bacteria usually were not the cause of deterioration because of the greater sensitivity of their spores to heat. According to the author, sterilized milk should be considered satisfactory if the milk after incubation at 37° C. for 3 d. (a) has not changed in appearance, (b) does not clot on boiling, (c) has no abnormal Breed count, and (d) has a plate count lower than 1000/ml. A simple test to differentiate raw, pasteurized and sterilized milk is presented.
W. C. van der Zant

62. Recherches en vue d'améliorer la qualité microbiologique des laits par ultracentrifugation (Researches concerning improvement of the microbiological quality of milk by ultracentrifugation). English summary. P. SIMONART and G. DEBEER. Neth. Milk Dairy J., **7**, 3: 117. 1953.

A study was made of the effect of ultracentrifugation (Sharpless) on the bacterial content of milk. Forewarming temp. ranging from 47-61° C. were used; centrifugal forces ranged from 2,459-22,031 G (10,000-30,000 r.p.m.). A centrifugal force of 10,000 G or more removed a considerable portion of the bacteria. Homogenization prior to centrifugation reduced the losses in milk solids. Ultracentrifugation

(9,836 G, 20,000 r.p.m.) removed nearly all spore-forming bacteria. *S. lactis* and *M. aureus* were removed to a greater extent than *E. coli*, *P. vulgaris*, and *Ps. fluorescens*.

W. C. van der Zant

63. Cathode rays and the dairy industry. B. Proctor, Massachusetts Inst. of Technol., Cambridge. Certified Milk, **27**, 5: 15. 1952. (Chem. Abstr., **47**: 12673b. 1953.)

S. Patton

DAIRY CHEMISTRY

64. The fat globule membrane of nonhomogenized and homogenized milk. I. The isolation and amino acid composition of the fat-membrane proteins. J. R. Brunner, C. W. Duncan, and G. M. Trout, Depts. of Dairy and Agr. Chem., Mich. Agr. Expt. Sta., East Lansing. Food Research, **18**, 5: 454. 1953.

Fat globule membrane material was obtained from unhomogenized and homogenized milk by cold separation followed by six washings of the respective creams with water and reseparation to remove all but closely held membrane materials. The creams were churned, the buttermilks dialized and the lipids extracted; after which the proteinaceous residue was lyophilized and amino acids determined by microbiologic methods.

Differences in the amino acid makeup of the fat globule membranes from homogenized and unhomogenized milk were interpreted to indicate that the main protein constituents of milk plasma make up a large proportion of the protein complex of the adsorbed surface layer on the fat globules of homogenized milk.

F. J. Doan

65. The fat globule membrane of nonhomogenized and homogenized milk. II. Differences in the electrophoretic patterns of the fat-membrane proteins. J. R. Brunner, H. A. Lillevik, G. M. Trout, and C. W. Duncan, Depts. of Dairy, Chem., and Agr. Chem., Mich. Agr. Expt. Sta., East Lansing. Food Research, **18**, 5: 463. 1953.

Electrophoretic mobility patterns of the proteinaceous material obtained from the fat globule membranes of unhomogenized and homogenized milk varied significantly. The material from the fat of homogenized milk seemed to contain one or two more components than that from the fat of unhomogenized milk.

F. J. Doan

66. The fat globule membrane of nonhomogenized and homogenized milk. III. Differences in the sedimentation diagrams of the fat-membrane proteins. J. R. Brunner, C. W. Duncan, and G. M. Trout, Depts. of Dairy and Agr. Chem., Mich. Agr. Expt. Sta., East Lansing; and M. Mackenzie, Div. of Chem., Naval Med. Research Inst., Bethesda, Md. Food Research, **18**, 5: 469. 1953.

Ultracentrifugal sedimentation-velocity diagrams obtained with the proteinaceous membrane material from the fat surfaces of unhomogenized and homogenized milk indicated one principal component for unhomogenized milk classified provisionally as a protein of globulin-like nature. On the other hand, it appeared that three components were present in the material from homogenized milk, tentatively identified as casein, Kekwick's whey-protein and an altered lactalbumin, β lactoglobulin or a complex of two or more constituent proteins.

F. J. Doan

67. Carotene. Determination in alfalfa meal treated with N,N′-diphenyl-p-phenylenediamine. H. L. Mitchell and R. E. Silker, Kan. Agr. Expt. Sta., Manhattan. J. Agr. Food Chem., **1**: 1163. 1953.

The AOAC method for determination of carotene in dehydrated alfalfa meal is not suitable for use with alfalfa meal treated with N,N′-diphenyl-p-phenylenediamine, as the passage of the diamine through the magnesium oxide adsorbent results in the production of a yellow color. A method is presented which employs tricalcium phosphate as the adsorbent, and which can be used when the diamine is present. By means of this method the potency of N,N′-diphenyl-p-phenylenediamine as a carotene stabilizer was evaluated.

S. Patton

68. A photoelectric method for determination of fat aldehyde values. R. M. Dolby, Dairy Research Institute, Palmerston North, New Zealand. J. Dairy Research, **20**, 2: 198. 1953.

In the determination of aldehyde values of slightly oxidized fat samples by Schibster's method (J. Indust. Eng. Chem., Anal. Ed., 1932), the color of the butterfat prevents accurate matching with the color standard. Data are presented which indicate that interference by butterfat color is eliminated and accuracy improved by measuring the color in a photoelectric colorimeter at a wavelength of 510 mμ. At this wavelength, the absorption by butterfat is almost negligible, and the necessity for a correction depends primarily upon the band width of the instrument used. The possibility of reporting results either as density values or as aldehyde values is discussed.

E. L. Thomas

69. Determination of the protein reducing value of milk as an indication of the presence of non-fat dry milk solids. R. P. Choi, A. F. Koncus, G. Cherrey, and R. J. Remaley, Am. Dry Milk Inst., Inc., Chicago, Ill. J. of Milk and Food Technol., **16**, 5: 241. 1953.

The authors have developed a method to detect reliquefied nonfat dry milk solids in pasteurized milk. The method is based on ferricyanide reducing value of the protein fraction of milk. The protein reducing value of 4.07 mg. potassium ferrocyanide per 100 ml. of milk

might be suggested as the maximum value for normal pasteurized milk. Values above this figure may indicate over pasteurization or the presence of reliquefied nonfat dry milk solids.
H. H. Weiser

70. Contribution à l'étude des méthodes de détermination de la phosphatase dans le lait. A. Scaut, Bull. de l'inst. agron. et des sta. de recherches de Gembloux. Tome XX, 3-4, 1952.
This report presents observations pertaining to details of the Kay and Graham, Scharer, and Saunders and Sager phosphatase tests. Analytical procedures, reagent stability, color measurements, and the effects of milk preservatives on the enzyme are discussed.
F. W. Bennett

71. A browning reaction involving copper-proteins. J. B. Thompson, Trace Metal Research Labs., Chicago. Symposium on Copper Metabolism. Johns Hopkins Press, 141. 1950. (Chem. Abstr., **47**: 11269f. 1953.)
B. L. Larson

72. Tests for the adulteration of human milk. R. A. Miller and R. W. B. Ellis, Univ. Edinburgh, Scot. Arch. Disease Childhood, **28**: 161. 1953. (Chem. Abstr., **47**: 11300i. 1953.)
B. L. Larson

73. Fat test of milk from cows in the Saratov Region. G. Glukhof and O. Mordovina, Molochnaya Prom., **14**: 38. 1953. (Chem. Abstr., **47**: 11419g. 1953.) B. L. Larson

74. The chemical composition of New Hebridean human milk. F. E. Peters, S. Pacific Commission, New Caledonia. Brit J. Nutrition, **7**: 208. 1953. (Chem. Abstr., **47**: 11421e. 1953.) B. L. Larson

75. Hexosamine in human and cow milk. C. A. C. Ross, Knightswood Hosp., Glasgow, Scot. Brit. J. Nutrition, **7**: 259. 1953. (Chem. Abstr., **47**: 11421g. 1953.) B. L. Larson

76. Variations in the ionic and lactose concentrations of milk. J. M. Barry and S. J. Rowland, Natl. Inst. Research in Dairying, Reading, Engl. Biochem. J., **54**: 575. 1953. (Chem. Abstr., **47**: 11428f. 1953.)
B. L. Larson

77. Protein content of the breast milk of African women. D. B. Jelliffe, Univ. Coll. West Indies, Jamaica. Brit. Med. J. **II**: 1131. 1952. (Chem. Abstr., **47**: 10651b. 1953.)
B. L. Larson

78. Detergents and milk tests. J. C. L. Resuggan, Dairy Inds., **18**: 403. 1953. (Chem. Abstr., **47**: 10755f. 1953.) S. Patton

79. Influence of rapid freezing of milk on the stability of its casein. G. Cerutti, Univ. Milan. Latte, **26**: 271. 1952. (Chem Abstr., **47**: 11583h. 1953.) S. Patton

80. Lactenin: the antistreptococcal agent in milk. A. T. Wilson, Alfred I. duPont Inst. of the Nemours Foundation, Wilmington, Del. Certified Milk, **27**, 4: 8. 1952. (Chem. Abstr., **47**: 12674a. 1953.) S. Patton

81. The iodine content of milk. R. Davidov and V. Anisimova, Timiryazev Agr. Acad., Moscow. Molochnaya Prom., **14**, 8: 33. 1953. (Chem. Abstr., **47**: 12676e. 1953.)
S. Patton

82. Indicator substances for the detection of hydrogenated oil when used as adulterant of clarified butterfat. K. C. Gulati and A. R. S. Kartha, Maharaja's Coll., Ernakulam. J. Sci. Ind. Research (India), **11B**: 346. 1952. (Chem. Abstr., **47**: 12679e. 1953.) S. Patton

DAIRY ENGINEERING

83. Proposed revision of American standard safety code for mechanical refrigeration. Sponsor — American Society of Refrigerating Engineers. Refrig. Eng., **61**: 10. 1953.
Printed as a copyrighted part of the October 1953 issue of Refrigerating Engineering, the Safety Code constitutes 19 pages and is the result of the deliberations of an American Standards Association Sectional Committee B9-1950 on recommendations made to it by the Interpretations Subcommittee-1950. The sections which are of general interest to all users of mechanical refrigeration equipment are: Sec. 8. Installation Requirements; Sec. 9. Refrigerating Piping, Valves, Fittings, and Related Parts; Sec. 10. Design and Construction of Equipment; Sec. 11. Refrigerant-Containing Pressure Vessels; Sec. 12. Relief Devices in General; Sec. 13. Relief Devices for Pressure Vessels; Sec. 14. Field Tests; and Sec. 15. Instructions. L. M. Dorsey

84. Evaporative cooling saves the day. W. E. Kahlert, Refrig. Eng., **61**, 10: 1072. 1953.
Evaporative cooling can be broken down into three main functions: (1) cooling of air, (2) humidification of air, and (3) cooling of water. One important item that processors of milk and milk products should keep in mind about evaporative air cooler and humidifier devices is the possible buildup of odor due to the presence of algae in the water holding pads. Water treatment to destroy algae is indicated. While natural draft and forced draft water cooling towers are used extensively there is a growing trend toward evaporative condensers in refrigeration installations in the dairy industry. Although the evaporative condenser adds materially to the installation cost of a refrigera-

tion system as compared to the conventional water tube condenser, the savings accruing over a long period of operation far offset the added cost. Evaporative condensers are the answer to the increasing cost of water supply, lowering water table, and municipal prohibition of water wastage. The author states that 1 lb. of water in the operation of an evaporative condenser will accomplish about 50 times that of a lb. of water going through the water tube condenser.
L. M. Dorsey

85. Necessary factors for most efficient dry ice refrigeration. W. BIGELOW, JR., Liquid Carbonic Corp. Quick Frozen Foods, **16**, 4: 73. 1953.

The author emphasizes insulation efficiency, proper load stacking, blower movement of air to insure an air blanket around the load and longitudinal and transverse movement through it, and proper protection to prevent warmup of goods from storage to trailer. A formula is given for estimating dry ice needs.
L. M. Dorsey

86. Reefer's function keyed to refrigeration and insulation. C. L. SCHNEIDER, Fruehauf Trailer Co. Quick Frozen Foods, **16**, 4: 76. 1953.

Brief descriptions are given of dry ice, "hold-over" plate and mechanical refrigeration systems for trailer refrigeration. Insulation must be adequate and designed to protect the loads the trailer is to carry and to meet the conditions under which it is to operate. The use of reflective material not only on the roof but also on the under body is emphasized because of the tremendous heat radiation from the surface of the road. Suggestions are made for securing proper mobile refrigeration, regardless of the type of refrigeration application.
L. M. Dorsey

87. Modern cold storage plant design. H. PETERSON, Engineer Consultant, Yakima, Wash. Ind. Refrig., **125**, 5: 23. 1953.

The author reviews the different ideas and designs being used throughout the United States to meet the many varied cold storage application problems. Numerous details of design, modern construction, and refrigeration applications are discussed.
L. M. Dorsey

88. Milk fat blending apparatus. V. SCHWARZKOPF (assignor to The Lathrop-Paulson Co.). U. S. Patent 2,662,751. 3 claims. Dec. 15, 1953. Official Gaz. U. S. Pat. Office, **667**, 3: 764. 1953.

An arrangement of a strainer weigh can for insuring the proper mixing of milk for sampling.
R. Whitaker

89. Brine tank elevator. T. C. SCHENK (assignor to Fruit Products Corp.). U. S. Patent 2,661,751. 8 claims. Dec. 8, 1953. Official Gaz. U. S. Pat. Office, **677**, 2: 410. 1953.

Construction details are given for a device for raising molds from the submerged track of a brine tank.
R. Whitaker

90. Milk measuring and material feeding device. W. R. PETERSON (assignor to International Harvester Co.). U. S. Patent 2,661,122. 9 claims. Dec. 1, 1953. Official Gaz. U. S. Pat. Office, **677**, 1: 165. 1953.

Details are given for a device for dispensing proportional volumes of milk and a dry material.
R. Whitaker

91. Plate heat exchanger. R. P. L. HYTTE (assignor to Aktiebolaget Separator). U. S. Patent 2,659,580. 6 claims. Nov. 17, 1953. Official Gaz. U. S. Pat. Office, **676**, 3: 812. 1953.

A design for a plate type regenerative heater and cooler, including a holding cell and means for diverting the liquid flow to and from a centrifuge.
R. Whitaker

92. Apparatus for the mechanical production of acoustic vibrations for use in emulsification, dispersion or like processes. E. C. COTTELL and J. E. GOODMAN. U. S. Patent 2,657,021. 5 claims. Oct. 27, 1953. Official Gaz. U. S. Pat. Office, **675**, 4: 1053. 1953.

Oils are homogenized or emulsified and solid materials are suspended in water and other liquids by passage through this device, which consists of a pump which forces the two phases through an orifice against the edge of a thin blade which, because of the liquid flow, vibrates in or near the ultrasonic range.
R. Whitaker

DAIRY PLANT MANAGEMENT AND ECONOMICS

93. Turning our problems into opportunities. EZRA TAFT BENSON. Milk Products J., **44**, 11: 27. 1953.

There is no real substitute for milk or milk products. Doctors and nutritionists prescribe and insist on their use. This fact needs more persistent selling.

There is no over-all surplus of dairy products. What the dairy industry needs is a better adjustment to the markets. The assistance of research in helping to discover better ways of producing and ultimately utilizing the milk is of prime importance. Close cooperation of dairy farmers, dairy plants and dairy research can help turn present problems into opportunities.
J. J. Janzen

94. Distributor knowledge and opinion of State milk control in Pa. W. T. BUTZ, C. W. PIERCE, and H. J. PRESTON, Pa. Agr. Expt. Sta., State College. Paper 1786, Journal Series. 1953.

Dealers evidenced a rather broad knowledge of the mechanics involved in the State's milk control program, including such points as marketing areas, time and place of hearings, and legal council representing their group at hearings. Only 9% of dealers interviewed expressed unfavorable opinion of the concept of milk control. Distributors felt costs were, and should be, the principal element in price setting. Dealers leaned toward using distribution costs in establishing resale prices rather than production costs. Proposals to have the Commission regulate the number of distributors in a marketing area or to establish and enforce production standards upon producers were strongly opposed by dealers. This same group was equally divided in regard to extending the Commission's power to include mandatory maximum pricing. Dealers believed that benefits had been derived primarily from the Commission's power to establish minimum producer and resale prices and a considerable number thought that the responsibilities in maintaining an "orderly marketing" of milk had been advantageous. R. W. Hunt

95. Producer knowledge and opinion of State milk control in Pa. W. T. BUTZ, C. W. PIERCE, and H. J. PRESTON, Pa. Agr. Expt. Sta., State College. Paper 1796, Journal Series. 1953.

Since the mid-thirties, Pa. dairy farmers have been operating under milk controls. Fifty-two % of the 1,121 producers interviewed knew that a governmental agency established milk prices. Ninety % of the informed producers knew that public hearings were held for the purpose of establishing milk prices, but very few of this group knew when or where. Less than 1/5 of the producers could estimate the price of class I milk within a $2.00 range and only 17% knew the month in which the most recent change took place. Two-thirds of the producers could estimate the blend price within a $2.00 range, however. Among the informed group, 3/4 of them favored continuation of milk control, but uninformed producers approved milk control by less than 1/3. Sixty-four % of the dairymen thought the price of milk was below that of production. However, producers attributed the unfavorable condition to a low relative price rather than to excessive distributor profit. Fewer than 1 in 10 of the informed group believed that milk control had been detrimental to the market milk industry and nearly 2/3 were convinced that the industry had benefited from the State program. The chief advantage was considered to be the establishment of minimum producer prices. R. W. Hunt

96. Consumer knowledge and opinion of State milk control in Pa. W. T. BUTZ, C. W. PIERCE, and H. J. PRESTON, Pa. Agr. Expt. Sta., State College. Paper 1807, Journal Series. 1953.

Four thousand five hundred and fourteen consumers were interviewed in this study. One-fifth of these knew of milk control. The analysis demonstrated the association between knowledge of control and consumer characteristics. For instance, consumers in the high income group were more apt to know about control than those of lower income; consumers whose parentage was traceable to an English-speaking country had a better knowledge of control than consumers of other nationalities; the longer the period of formal education, the larger the proportion of respondents who were aware of the agency; and home-delivery families were considerably better informed than store purchasing families. Slightly over 1/2 the families prefer alternate-day to daily delivery. Less than 1/5 of those desiring daily delivery were willing to pay extra for the service. More than 50% of the informed consumers thought the control system had started during or after World War II. This same informed group had a good idea of milk price determination, but only a limited knowledge about the time and place of hearings. A milk control program should: (1) aim at maintaining good quality, (2) assure reasonable profits to producers and dealers, (3) reduce retail prices. The chief advantage of the control setup, as viewed by the informed, was that it resulted in "fair" prices. R. W. Hunt

97. How to use food brokers. H. W. CLARKE, Natl. Food Brokers Assoc. Milk Prod. J., **44**, 12: 32. 1953.

The problem of selecting and using a broker is discussed at some length. In selecting a broker it is necessary to decide on the kind of service required and the representation desired.

To get the greatest value from the brokerage representation, one should keep them thoroughly informed, post them promptly on any price changes, let them know of new items to be added to the general line well in advance of the trade, and inform them, in advance, of any special advertising or merchandising plans under consideration. J. J. Janzen

98. A sound dairy program can be developed. M. GEBERT, Dairy Prod. Mkt. Assoc., Inc., Chicago, Ill. Milk Prod. J., **44**, 12: 27. 1953.

In building toward better dairy programs—better relationship between supply and demand—the following three choices have been presented: (1) ask government to enter the marketing field to be the stabilizer, (2) ask private enterprise to assume the responsibility, or (3) ask private enterprise to do the job with certain help from the government.

In the author's opinion the best approach would be to build a long-time stabilization program for dairy products on a step by step basis. The first step would be for the Commodity Credit Corporation to gradually turn

over to a producer-controlled stabilization corporation the actual buying and selling of dairy products as required by our present price support laws.

The advantages of such a step would be greater flexibility of the stabilization corporation with respect to personnel, the stabilization corporation would have greater incentives for efficiency and would be more adaptable to changing conditions, and the price support program would have a much better chance for success.

The second step, of course, would be to make the stabilization corporation self-financing and put it under the control of a national stabilization board of producers appointed by the president. J. J. Janzen

99. Dairy products for military subsistence. J. M. McIntire, QMC Depot, U. S. Army, Chicago, Ill. Proc. of the 22nd Ann. State Coll. of Wash. Inst. of Dairying, Pullman. 39. 1953.

In addition to fresh milk, ice cream, cheese and butter, all of which are bought on federal specifications, the military establishment is interested in concentrated milk, sterilized milk, dry whole milk, recombined milk, ice cream mix in powder and paste form, modified dry milk products used for coffee, dry whipping cream, and canned processed cheese and cheese spread. J. Tobias

100. An economic analysis of butter-nonfat dry milk plants. S. H. Walker, H. J. Preston, and G. T. Nelson, Idaho Agr. Expt. Sta., Moscow. Research Bull., 20. 1953.

The bull. is an extensive report of processing costs in 12 butter-powder plants located in Wash., Ore., and Idaho. Five of these plants produce roller process powder and seven spray processed powder. Processing costs were obtained for each of 17 functions in four broad categories: (1) overhead, (2) joint operating, (3) butter manufacturing, and (4) powder manufacturing. Data collected on items of investigation were the result of physical measurements and interviews. The results show that as the milk volume of a plant increases, so does its efficiency, but efficiency lags in respect to volume, unit cost declines as size of operation increases, and consequently, there is a real economic incentive to increase size of operation as a result of low marginal costs.

R. W. Hunt

101. Production of manufactured dairy products — 1951. W. D. Bormuth, B. H. Bennett, and J. M. Cooley, U.S.D.A., Washington, D. C. Statistical Bull., 120. 1952.

Statistics are provided indicating the production of all types of manufactured dairy products in the U. S. R. W. Hunt

102. Will the U. S. dairy industry prosper in the years ahead? P. H. Tracy, Dept. of Food Technol., Univ. of Ill., Urbana. Ice Cream Trade J., **49**, 10: 102. 1953.

Signs point towards a higher standard of living for the American people. The dairy industry should be able to cash in on people's desire for good dairy products through greater selling efforts and by supplying the consumer with high quality products at as low a price as will permit a reasonable return to labor, management and invested capital. Confidence in our product and ourselves should make it possible to keep the per capita consumption curve of dairy products headed upward.

W. H. Martin

FEEDS AND FEEDING

103. Rations for livestock in Britain. J. Duckworth, Nature, **172**, 4384: 844. 1953.

A summary is given of the conference held on "Problems in Providing Rations for Britain's Livestock" held Oct. 1 and 2, 1953, at Rowett Research Institute, Aberdeen, Scotland by the Scottish Group of the Nutrition Society. Subjects covered included the effects of abolishing government control of feedstuffs, the influence of grassland farming, protein and vitamin B_{12} requirements, and the use of antibiotics.

R. Whitaker

104. Observations upon an unidentified factor in feedstuffs stimulatory to cellulose digestion in the rumen and improved liveweight gains in lambs. E. W. Ruf, W. H. Hale, and W. Burroughs, J. Animal Sci., **12**, 4: 731. 1953.

The results presented indicate that a factor stimulatory to rumen microorganisms is fairly widespread in feeds commonly fed to cattle and sheep. Yeast and manure extract were particularly rich sources of the material. Fractionation of these materials indicates that the factor is heat stable, soluble in H_2O and low concentration of ethanol. Absorption did not occur on ion-exchange resins and ashing destroyed the factor, indicating that the active material was not a mineral. It was absorbed on Norite and eluted with acetone and ethanol. The factor does not appear to be a B-complex vitamin or a protein. O. T. Stallcup

105. Value of urea nitrogen in rations containing different carbohydrate feeds. M. C. Bell, W. D. Gallup, and C. K. Whitehair, J. Animal Sci., **12**, 4: 787. 1953.

The value of urea as a source of nitrogen in rations containing different carbohydrate feeds was determined in three series of digestion and nitrogen balance trials with steers.

Addition of urea had very little effect on apparent digestibility of nutrients other than protein which was increased in all rations. It improved nitrogen retention to a significant

extent when added to each ration, a greater improvement being made when it was added to the corn rations than when added to molasses-containing rations. Biological values of the total nitrogen of the supplemented rations indicated that the urea nitrogen was utilized with equal efficiency in rations of different cereal grains and sweet potatoes, and with less efficiency in molasses-containing rations. In a comparison of urea with soybean meal in barley rations, small differences in nutrient digestibility and nitrogen retention favored soybean meal supplement. O. T. Stallcup

106. Total digestible nutrients as a measure of feed energy. L. A. MAYNARD, J. Nutrition, **51**, 1: 15. 1953.

The author reviews the development of the TDN concept in nutrition, and presents the weaknesses of the current formula for calculating TDN. A revised formula for calculating TDN is discussed as well as a new factor for converting lb. TDN into calories.

O. T. Stallcup

107. Use of indicators in the measurement of the dry matter intake of grazing animals. W. A. HARDISON and J. T. REID. J. Nutrition, **51**, 1: 35. 1953.

In a series of trials in which Cr_2O_3 was used as an indicator of dry matter intake of steers on pasture and on hand-feeding, it was found that the Cr_2O_3 content of the feces voided at intervals of the day was extremely variable. It was observed, however, that accurate intake estimates could be derived from samples of feces taken at any time provided that the rate of recovery of Cr_2O_3 is known. The data presented indicate that factors influencing the rate of Cr_2O_3 recovery from the feces taken in the morning may contrawise effect a change in the recovery of that substance in the feces taken in the afternoon. The mean rates of recovery of Cr_2O_3 from the feces taken from grazing steers at 6:00 A.M. and 4:00 P.M. were 71.8 and 129.3%, respectively; compounding these feces samples on an equal wet-weight basis resulted in an average recovery of 99.95% of the Cr_2O_3 ingested by grazing steers.

O. T. Stallcup

108. De toepassing van weipasta en weipoeder by de bereiding van silovoeder (The use of whey paste and whey powder in the preparation of silage). H. VAN DER MOLEN and D. KAPELLE, Landbouwk. Tydschr., **64**: 684. 1952.

The advantages of using whey products in silage are discussed. W. C. van der Zant

109. The influence of feeding silage to dairy cows on the flavor and other properties of the milk. E. D. MCGLASSON and C. K. GORRIE, Univ. of Idaho, Moscow. Proc. of the 22nd Ann. State Coll. of Wash. Inst. of Dairying, Pullman. 1. 1953.

The feeding of peavine, alfalfa-grass, and corn silages did not affect titratable acidity, pH, butterfat content, total solids and milk yield.

Peavine silage did not produce feed or silage flavors of greater intensity than corn or grass silage. Morning milk obtained 14 hr. after silage feeding scored higher in flavor than evening milk.

Jersey cows produced better flavored milk than Holsteins when fed peavine and alfalfa-grass silage. It was observed, however, that milk from individual cows within breed varied more in flavor score than the differences observed between the different silages.

J. Tobias

110. Effects of feeding different grades of hay and cod-liver oil concentrate to dairy cattle. H. B. ELLENBERGER, J. A. NEWLANDER, and C. H. JONES, Vt. Agr. Expt. Sta., Burlington. Bull., 570. 1953.

Simple rations containing little or no legumes supplied ample amounts of calcium and phosphorus to support normal growth. Calves and young heifers fed best quality early cut hays did better than those fed poor hay plus vitamins A and D. However, the group fed the cod-liver oil concentrate (Vit. A and D) made better gains than the controls. R. W. Hunt

111. Value of pearl millet pasture for dairy cattle. S. P. MARSHALL, A. B. SANCHEZ, H. L. SOMERS, and P. T. DIX ARNOLD, Fla. Agr. Expt. Sta., Gainesville. Bull., 527. 1953.

Yield of TDN per acre and length of grazing season were larger for millet pasture grazed by lactating cows than for that utilized by heifers. Well developed dairy heifers in good condition were able to make satisfactory growth on millet pasture alone between 7 and 10 mo., while small and/or thin animals in this age range gained subnormally. Ave. daily concentrate consumption per cow for the 3 years was 8.6 lb. This supplied 39.5% of the calculated TDN, with the remaining 60.5% coming from pasturage. R. W. Hunt

112. Feed supplements. Genus Bacillus as a source of growth stimulants. J. C. LEWIS, K. IJICHI, T. F. SUGIHARA, P. A. THOMPSON, N. S. SNELL, G. ALDERTON, and J. A. GARIBALDI, Western Reg. Research Lab., Albany, Cal. J. Ag. Food Chem., 1: 1159. 1953.

A search for antibiotic feed supplements has been centered on the genus *Bacillus* because many strains of bacteria of this group grow rapidly on simple media to produce a wide variety of antibiotics. The empirical approach, involving chick-feeding tests at an early stage of selection, has yielded several stocks which give 5 to 10% greater growth responses than the control chicks at 10 wk. More intensive investigations of these stocks, now in progress,

are intended to identify the growth-promoting substances, to provide methods for the rapid assay of these substances, and to develop economical forms of the supplements.

S. Patton

113. Influence of kind of pasture on persistency of milk production. Anon., Ky. Agr. Expt. Sta., Lexington. 65th Ann. Rept., 36. 1952.

A mixture of orchard grass and ladino-clover produced grazing that gave the most stimulation to milk production. The ave. persistence of milk production while grazing this mixture was 97.2%, as compared with 85.2% for Ky.31 fescue and ladino, 83% for Ky.31 fescue alone, and 82.8% for Ky. bluegrass and ladino. Straight stands of four grasses—two pastures each of orchard grass, Ky.31 fescue, bluegrass, and Lincoln bromegrass were established early in Sept. 1951. These were grazed during three 4-wk. test periods during the summer of '52, and the ave. persistency ratings were bluegrass 94.4%, bromegrass 93.1%, orchard grass 90.6%, and Ky.31 fescue 70.8%. Ratings were determined by comparing the production for the 4th wk. with that for the wk. prior to the test period. R. W. Hunt

114. Winter pasture economical dairy feed in 2-year test; stored roughage necessary. J. T. Miles and J. W. Lusk, Miss. Agr. Expt. Sta., State College. Miss. Farm Research, **16**, 8: 1. 1953.

Winter pasture is an economical source of feed for dairy cows and herbage from this source has a milk stimulating effect. Results also showed the need for preserving forage crops during favorable periods for use when weather conditions do not permit pasturing animals. R. W. Hunt

115. Expeller vs. solvent process linseed oil meal for milking cows. A. D. Pratt and C. F. Monroe, Ohio Agr. Expt. Sta., Wooster. Bull., 731. 1953.

Two experimental feeding trials were conducted, in which the only planned difference was the feeding of expeller vs. solvent extracted linseed oil meals. The first trial involved the use of 13 pairs (26 animals) of lactating cows and the second, 25 pairs (50 animals). In each trial the cows were divided into two groups. All groups were fed both types of linseed oil meal, plus other concentrates and alfalfa hay, for 10 d., then passed through a 10-d. period in which they were fed the specific type of meal for that experiment, and followed by 10 d. in which records were kept. Production of 4% (FCM) milk, body weight changes and ratio of grain eaten per lb. of 4% milk showed that the extraction of linseed meal with hexane does not reduce the feeding values of linseed oil meal when the difference in energy content can be compensated. R. W. Hunt

116. Effect of adding various levels of an aureomycin supplement to starter on growth and blood constituents of Guernsey calves. R. D. Mochrie, K. L. Dolge, H. D. Eaton and F. I. Elliott, Storrs (Conn.) Agr. Expt. Sta. Inf., 48 — A preliminary report. 1953.

Twenty Guernsey calves were raised from the 8th to the 119th d. on chopped grass—clover hay and one of five levels of Aurofac supplement: 0, 10, 20, 40, 60 lb. per ton of calf starter. Half the calves were raised in a controlled temperature and the others in an uncontrolled temperature. No differences were noted in feed consumed or feed efficiency for the various levels of Aurofac, but the calves fed Aurofac consumed slightly more starter than the control group. The only apparent effect of uncontrolled temperatures on feed consumption was that hay intake increased slightly. Carotene intake and estimated vitamin A body stores, plasma vitamin A, gains in live weight, height at withers, heart girth and girth of paunch showed no differences between groups. However, gain in weight at 35 and 119 d. appeared to be about 5% higher for all groups of supplemented calves. R. W. Hunt

117. Rate of carotenoid loss in artificially-dehydrated alfalfa under farm storage. K. L. Dolge, J. E. Rousseau, Jr., H. D. Eaton, and L. A. Moore, Storrs (Conn.) Agr. Expt. Sta., Storrs, and B.D.I., U.S.D.A. Presented at meeting Eastern Div., A.D.S.A. Sept. 20, 1953.

During the course of studies conducted 1950-53 on the feeding value to dairy cattle of artificially-dehydrated alfalfa, samples of these as well as field-cured hays were obtained at successive 4-wk. intervals for carotenoid analysis. Investigation of the rate of change of the carotenoid content during the time stored, Sept. through July, under hay mow conditions indicated a decreasing trend which was essentially linear. The range in the rate of change of the carotenoid content per 4-wk. period was from −6.80 to −0.17 mg. per lb. of dry matter. Inspection of the carotenoid content at the beginning of the storage period and the rate of carotenoid loss during storage indicated an association between these two variables; the hays having higher initial carotenoid content had more rapid rates of carotenoid decrease during storage. By regression methods this relationship was best described by the following: $Y = -0.14 + 0.0873X - 0.002X^2$ in which Y equals the expected carotenoid content decrease per 4-wk. period in mg. per lb. of dry matter under farm storage conditions and X equals the initial carotenoid content at the beginning of the storage period with applicable limits for X of 6 and 110 mg. per lb. of dry matter.

Author's Abstract

118. All weather salt block. H. Futter. U. S. Patent 2,658,476. 7 claims. Nov. 10,

1953. Official Gaz. U. S. Pat. Office, **676**, 2: 432. 1953.

A block of salt covered on all but one end with a water repellent material, and the other end so shaped that the exposed end is not on top unless the animal inserts its nose and pivots the block upward while licking the salt.

R. Whitaker

119. Carotene. Factors affecting destruction in alfalfa. K. A. Walsh and S. M. Hauge, Dept. of Biochem., Purdue Univ., Agr. Expt. Sta., Lafayette, Ind. J. Agr. Food Chem., **1**, 16: 1001. 1953.

The rapid destruction of carotene in alfalfa during field curing has been attributed to the summation of the losses by enzymatic and photochemical processes. Accurate evaluation of the extent of destruction under field conditions is confused by continual changes in temperature, moisture, light intensity, and physical state of the tissue. By incubating aqueous suspensions of macerated alfalfa leaves under controlled conditions it was possible to measure separately the effects of temperature, pH, heat treatments, and cyanide upon the enzymatic, photochemical, and autoxidative losses of carotene.

The enzyme system was found to have a temperature optimum of about 43° C., to be more active at pH 4 to 5 than at higher pH values, to be heat labile, and to be partially inhibited by cyanide. Photochemical destruction was not markedly affected by pH changes between 4 and 8, by temperature changes between 10 and 45° C., or by prolonged heat treatments after enzyme inactivation. The loss of carotene in the absence of enzymatic and photochemical destruction was attributed to autoxidation. This mechanism appears to be of minor importance below 40° C., and is little affected by pH changes between 4 and 8. It is difficult to conclude that one mechanism of carotene destruction predominates over the other during field curing. Both contribute to carotene loss and both must be controlled to reduce the total loss. S. Patton

120. Omaha makes feed out of garbage. H. H. Ulrich, Sanitary Comm., Omaha, Nebr. Am. City, **68**, 8: 92. 1953. (Chem. Abstr., **47**: 10782b. 1953.) S. Patton

121. Adding animal fats to feed formulas. B. S. Schweigert, L. R. Dugan, Jr., and O. H. M. Wilder, Am. Meat Inst. Foundation, Chicago. Am. Meat Inst. Foundation, Circ. **7**: 3. 1953. (Chem. Abstr., **47**: 10764f. 1953.) S. Patton

122. Supplementation of nitrogen in orange peels for cattle feeding. R. Volcani and H. Schindler, Agr. Research Sta., Rehovoth, Israel. Bull. Research Council Israel, **2**, 1: 17. 1952. (Chem. Abstr., **47**: 10764g. 1953.) S. Patton

123. High-protein animal feed. S. Longhi. Ital. 470,433, Apr. 7, 1952. (Chem. Abstr., **47**: 10766c. 1953.) S. Patton

124. The analyses of animal feeds and the interpretation of the results which they furnish. G. Chariet-Lery, A. Francois, and A. M. Leroy, Lab. zootech. inst. natl. agron., Paris. Ann. inst. natl. recherche agron. Ser. D., Ann. zootech. **3**: 45. 1952. (Chem. Abstr., **47**: 11598c. 1953.) S. Patton

125. Utilization of dietary carbohydrates by ruminants. R. Jarrige. Ann. nutrition et aliment, **7**: 339. 1953. (Chem. Abstr., **47**: 11378d. 1953.) B. L. Larson

126. Factors affecting the utilization of food by dairy cows. VII. The effect of limited water intake on the digestibility and rate of passage of hay. C. C. Balch, D. A. Balch, V. W. Johnson, and J. Turner, Univ. Reading, Engl. Brit. J. Nutrition, **7**: 212. 1953. (Chem. Abstr., **47**: 11386g. 1953.) B. L. Larson

127. Effect of diet on milk yield of the ewe and growth of her lamb. W. Thomson and A. M. Thomson, Rowett Research Inst., Bucksburn, Scot. Brit. J. Nutrition, **7**: 263. 1953. (Chem. Abstr., **47**: 11387d. 1953.) B. L. Larson

128. Digestibility of lucerne hay with special reference to experimental technique in digestion trials. II. J. W. Groenwald, S. J. Myburgh, and J. G. Louw, Onderstepoort Labs., Pretoria, S. Africa. Onderstepoort J. Vet. Research, **25**, 4: 105. 1952. (Chem. Abstr., **47**: 12695g. 1953.) S. Patton

129. Harvest of sorghum fodder. A. Cotte and P. Grignac, École natle. agr., Montpellier, France. Progr. agr. et vit., **139**: 244. 1953. (Chem. Abstr., **47**: 12696a. 1953.) S. Patton

130. Themeda quadrivalvis as cattle feed. B. K. Das, N. C. Mukherjee, and B. Sen, Animal Nutrition Research Scheme, Assam, Gauhati. Science and Culture (India), **18**: 492. 1953. (Chem. Abstr., **47**: 12696d. 1953.) S. Patton

131. Ensiling experiments with the addition of "Kofa" salt to ensiled crops. S. Eriksson, Kgl. Lantbruksakad. Tidskr., **92**: 213. 1953. (English summary). (Chem. Abstr., **47**: 12696e. 1953.) S. Patton

132. Harvesting and preserving forages. L. A. Moore and J. B. Shepherd, U. S. Bur. of Dairy Ind., Washington, D. C. Certified Milk, **28**, 2: 11. 1953. (Chem. Abstr., **47**: 12696i. 1953.) S. Patton

133. Ruminant nutrition. C. F. Huffman, Mich. State Coll., East Lansing. Ann. Rev. Biochem., **22**: 399. 1953. (Chem. Abstr., **47**: 10644b. 1953.) B. L. Larson

134. Antibiotics in the growth of ruminant animals. C. B. Knodt, State College, Pa. Antibiotics and Chemotherapy, **3**: 442. 1953. (Chem. Abstr., **47**: 10614h. 1953.) B. L. Larson

HERD MANAGEMENT

135. A comparative cost analysis of farm through receiving point handling costs of milk in can and tank, western Washington, 1952. E. L. Baum and D. E. Pauls, Dept. of Agr. Econ., State Coll. of Wash. Proc. of 22nd Ann. State Coll. of Wash. Inst. of Dairying, Pullman. 29. 1953.

Assuming a route length of 65 miles and a milk volume of 12,500 lb. daily, a combination plan of daily can and alternate day tank pickup proved most expensive with average daily volume of shipper up to 5,000 lb. Alternate day tank pickup was cheapest for producers of more than 160 lb. daily. Daily can pickup with 40% return of empty cans the same day was intermediate in cost.

The analysis took into consideration such factors as relative costs of refrigeration, investment cost, depreciation, level of capacity utilization, cost of truck operation, etc.

J. Tobias

136. Dairy calves — their development and survival. P. T. Dix Arnold and R. B. Becker, Fla. Agr. Expt. Sta., Gainesville. Bull., 529. 1953.

Growth rate of male Jersey fetuses was slightly faster than that of females, from 90 d. to full term. First calves dropped by Jersey heifers weighed about 5 lb. less than subsequent calves. Only at extremely advanced age of dams was there a tendency for decline in birthweight of calves. Ave. gestation periods were 277.9 d. for 421 males and 276.5 d. for 411 female Jersey calves. The sex ratio of Jerseys over a 21-yr. period was 51.6% males among 893 individuals. Fourteen pairs of normal twins were carried an ave. of 270.6 d., and there was a single instance of triplets. Of 408 heifer calves born, 4.9% were stillborn or died at birth. Losses under 6 mo. of age amounted to 12.2%, with 1.2% being freemartins. Losses past 6 mo. of age totaled 6.9%. Failure to conceive and difficult breeding eliminated 9.6% of older heifers.

R. W. Hunt

137. Loose housing or stanchion-type barns for dairy cattle? S. A. Witzel and E. E. Heizer, Wis. Agr. Expt. Sta., Madison. Bull., 503. 1953.

Over a period of 10 yr., two comparable herds of Holstein cows were housed simultaneously in a conventional stanchion barn and an uninsulated loose-housing barn. A third comparable herd was housed in an insulated loose-housing barn which was operated for 2 yr. as a closed warm barn and 4 yr. as an open loose-housing barn. The herds produced equally well in a warm stanchion barn or loose-housing barn. No relation existed between low temperature and milk production. Feed requirements per lb. of milk was essentially the same for all barns. More bedding was required for loose-housing barns than stanchion barns. Loose-housing in a closed warm barn was found to be unsatisfactory. General health of animals was about the same for both housing systems. However, injuries were almost absent in loose-housing. Calves need special attention in cold weather only at the time of calving. It is desirable to remove all manure in the spring and to keep the barn clean during the fly season.

R. W. Hunt

138. Milk cooler. R. Markley (assignor to Dairy Equipment Co.). U. S. Patent 2,661,607. 9 claims. Dec. 8, 1953. Official Gaz. U. S. Pat. Office, **677**, 2: 369. 1953.

An insulated cabinet is described for cooling milk in cans. Cooling coils are provided in the bottom, a motor driven agitator maintains a uniform temperature, and the cans are inserted and removed through a side door.

R. Whitaker

139. Container closure. E. C. Oldenburg, U. S. Patent 2,661,861. 3 claims. Dec. 8, 1953. Official Gaz. U. S. Pat. Office, **677**, 2: 443. 1953.

A milk can is described with a hinged lid.

R. Whitaker

140. Signaling device for vacuum milking machines. H. W. Hein (assignor to International Harvester Co.). U. S. Patent 2,660,976. 7 claims. Dec. 1, 1953. Official Gaz. U. S. Pat. Office, **677**, 1: 122. 1953.

A device is described which emits a whistling warning sound when the vacuum on a milking machine falls to a predetermined level.

R. Whitaker

141. The Dairy Herd Improvement Association program. J. F. Kendrick, U.S.D.A., Washington, D. C. Farmers Bull., 1974. 1953.

Details are given for the organization and operation of a Dairy Herd Improvement Association. R. W. Hunt

142. The analysis of demand for farm products. K. A. Fox., U.S.D.A. Washington, D. C. Tech. Bull., 1081. 1953.

Demand-supply structures for a number of farm products are provided. These diagrams have been helpful in deciding whether consumer demand equations for various products are statistically measurable and, if so, whether single equation or simultaneous equation methods are required. The stability and reliability of some of these demand equations during 1942-51 are examined. R. W. Hunt

143. Regular hired workers on commercial dairy farms in Connecticut, April 1950-April 1952. R. G. BURNIGHT, W. C. MCKAIN, JR., and P. L. PUTMAN, Storrs (Conn.) Agr. Expt. Sta. Bull., 267. 1953.

A survey was made of the labor forces of 345 dairy farms with 20 or more dairy cows. Experience, length of service, wages, housing, working hours and reasons for hired personnel leaving individual farms are discussed.

R. W. Hunt

144. Oklahoma farm fitted grade "A" milking parlor for plant producer dairies. G. W. A. MAHONEY, G. L. NELSON, and J. J. FRYREAR, Okla. Agr. Expt. Sta., Stillwater. Plan 20. 1953.

This is a detailed plan of a milking parlor showing construction, and exact amounts and sizes of necessary building materials. A charge of 25¢ is made for this plan. R. W. Hunt

145. Costs and returns on dairy and poultry farms. A. L. OWENS, R. I. Agr. Expt. Sta., Kingston. Misc. Pub., 43. 1952.

Cost and return data of 13 dairy farms and 8 poultry farms are presented.

R. W. Hunt

146. Milk strainer for separator supply cans. W. H. HARSTICK (assignor to International Harvester Co.). U. S. Patent 2,656,928. 5 claims. Oct. 27, 1953. Official Gaz. U. S. Pat. Office, **675,** 4: 1025. 1953.

A strainer is described suitable for inserting in the supply tank of farm separators.

R. Whitaker

147. Milk cooler. J. R. BOYLE (assignor to Edward A. Mertes). U. S. Patent 2,659,579. 10 claims. Nov. 17, 1953. Official Gaz. U. S. Pat. Office, **676,** 3: 812. 1953.

A device for cooling milk in a can, consisting of a cooling coil which rotates by a small turbine, using the exhaust cooling water.

R. Whitaker

148. Dehorning tool. V. L. FENDER, U. S. Patent 2,659,142. 9 claims. Nov. 17, 1953. Official Gaz. U. S. Pat. Office, **676,** 3: 685. 1953.

Horns of cattle are removed by this device, which consists of two lever operated knives which move together across an orifice through which the horn is placed. R. Whitaker

149. Notes on the corrosion of aluminum dairy equipment by water. G. H. BOTHAM and W. R. BRYSON, A. P. V. Laboratories, London, Engl. J. Dairy Research, **20,** 2: 154. 1953.

Pronounced pitting corrosion of aluminum alloy milk pails encountered on several farms was associated with a relatively high copper content of well water used for washing and rinsing. In the most striking case examined, well water which passed through a copper pipe was found to contain 7.8 p.p.m. of copper. Water of a similar character when passed through a lead pipe contained less than 0.01 p.p.m. of copper and caused negligible corrosion of aluminum. In other instances, where corrosion of aluminum utensils was observed, the water supplies contained from 1 to 4 p.p.m. of copper.

It was demonstrated that added copper could be effectively removed from water by passing it through a column of Zeocarb 215, a commercially available synthetic resin.

E. L. Thomas

ICE CREAM

150. High-temperature short time pasteurization of ice cream mix. H. B. SHEFFIELD, Cherry-Burrell Corporation, San Francisco, Cal. Proc. of the 22nd Ann. State Coll. of Wash. Inst. of Dairying, Pullman. 107. 1953.

Two systems of continuous pasteurization are described. In the first system the ingredients are heated to 140° F. in conventional vats at which point the frozen and dry ingredients may be added. In the other system all ingredients in liquid form are assembled cold and processed in a plate heater which includes a regenerator section. Separate processing vats are necessary in this system to render into a liquid form such ingredients as chocolate liquor, frozen cream, frozen egg yolk and stabilizers. All liquids then are metered into a weigh tank by means of a push button control panel. The mix is homogenized at 175° F. J. Tobias

151. Preparation of low fat high solids mixes. W. H. MARTIN, Kan. State Coll., Manhattan. Proc. of the 22nd Ann. State Coll. of Wash. Inst. of Dairying, Pullman. 101. 1953.

A summary of problems in the manufacture of ice milk of both the soft and hard frozen varieties. Suggested formulas are given for soft-serve products, hardened ice milk and malt base. J. Tobias

152. Frozen stick confections, past-present-future. C. O. LUND, C. O. Lund and Associates, Chicago, Ill. Ice Cream Rev., **37,** 4: 50. 1953.

The increasing popularity of frozen stick confections is indicated by the fact that sales have doubled since 1946. It is estimated that the more than 3,000,000,000 bars sold in 1952 represent a total of 70,000,000 gal. of ingredients with a value of not less than $112,000,000.

The author suggests that with some improvement in quality, packaging, merchandising, and standardization of sizes, the popularity of frozen stick confections could be doubled, thus adding another $112,000,000 to the ice cream manufacturers' income.

Several suggestions are made for increasing sales and profits from frozen stick confections.
W. J. Caulfield

153. Pectin production. Pilot plant production of low-methoxyl pectin from citrus peel. R. P. GRAHAM and A. D. SHEPHERD, W. Reg. Research Lab., Albany, Cal. J. Agr. Food Chem., **1**, 16: 993. 1953.

Low-methoxyl pectins are versatile materials which make possible the preparation of many new food products and the preparation of old food products in new or easier ways. Use of various modified pectins is restricted, however, by limited availability. Suitable grades and types of low-methoxyl pectin can be prepared in good yield from citrus peel. Care is required throughout the manufacturing operation to avoid excessive loss of pectin quality. Procedures have been developed on a pilot plant scale. Three stages are involved: preparation of peel for extraction, extraction of pectin and clarification of the extract, and chemical modification and isolation of low-methoxyl pectin. All operations are conducted in an aqueous phase, in contrast to present production methods. An integrated, practical process for making low-methoxyl pectin from citrus peel has been developed. Operating conditions, procedures, and equipment are discussed in a manner designed to assist prospective users of the process.
S. Patton

154. Super market survey on ice cream. ANON. Ice Cream Trade J., **49**, 10: 46. 1953.

The Ice Cream Trade Journal and Super Market Merchandising submitted 19 questions on ice cream merchandising practices to 6,000 super markets. This article discusses in detail the results of this survey.
W. H. Martin

155. A factual comparison of the experiences of manufacturing plants with Mellorine and ice cream. W. A. WENTWORTH, The Borden Co., New York. Ice Cream Trade J., **49**, 10: 68. 1953.

Plants in Chicago, Elgin, St. Louis and Kansas City (Group I) making vegetable oil products showed a decline of 7.1% in the use of butterfat during the period June, 1952, through May, 1953, against a decline of 0.2% in plants located in Cedar Rapids, Milwaukee and Indianapolis (Group II), which did not make the vegetable fat product. The use of serum solids increased 22.8% in Group I plants vs. an increase of 1.4% in the Group II plants. Ice cream production in the Group I plants declined 9.3% from the previous 12 mo. vs. 4.1% in the Group II plants.
W. H. Martin

156. How to build a successful "soft-serve" business. J. TOBIAS, Dept. of Food Tech., Univ. of Ill., Urbana. Ice Cream Trade J., **49**: 96. 1953.

"Soft ice cream" is a frozen dessert which is sold directly from the freezer to the consumer. Due to its low fat content, in most states it is called ice milk; in other states, it must meet ice cream fat standards.

Excessive saltiness and sweetness, common defects in this low fat product, may be avoided by limiting the solids non-fat content to 12.5% and the sugar to 13%. Overrun should be about 35 to 45% for a 28 to 32% total solids mix and the freezing temperature should fall into the limits of 18-21° F. If the product is to be hardened, it should be stored at –10° F. and on slow days the product may become watery in appearance and too soft when served, due to alternate freezing and thawing.

A good merchandising program will include attention to store appearance, sanitation, uniform serving, advertising and proper dispensing of the product by trained operators.
W. H. Martin

157. Survey shows what future holds for soft frozen desserts. P. H. TRACY, Dept. of Food Technol., Univ. of Ill., Urbana. Quick Frozen Foods, **16**: 4, 55. 1953.

A survey conducted in the North Central section of the country on the soft served frozen dessert industry was reported at the annual meeting of the International Assn. of Ice Cream Manufacturers in Boston, October, 1953. The items discussed included economic outlook, effect on ice cream sales, technological and merchandising aspects of soft frozen desserts.
L. M. Dorsey

158. Block ice cream slicer. R. H. BLOXHAM. U. S. Patent 2,660,962. 2 claims. Dec. 1, 1953. Official Gaz. U. S. Pat. Office, **677**, 1: 118. 1953.

Details are given for an automatic ice cream sandwich making machine, using cut brick slices.
R. Whitaker

159. Nozzle for making packaged sundaes. F. T. MOSER. U. S. Patent 2,660,964. 1 claim. Dec. 1, 1953. Official Gaz. U. S. Pat. Office, **677**, 1: 119. 1953.

A filling head is described for placing ice cream from the freezer into cups.
R. Whitaker

160. Base materials for frozen desserts. J. R. KATZ. U. S. Patent 2,658,831. 8 claims. Nov. 10, 1953. Official Gaz. U. S. Pat. Office, **676**, 2: 539. 1953.

A base for making frozen desserts consisting of an edible oil, sugar, propyl 3, 4, 5 trihydroxy benzoate, and locust bean gum, aerated and formed into blocks which float.
R. Whitaker

161. Forming head and method of forming ice cream tarts. S. J. DAANEN and T. H. LUTSEY. U. S. Patent 2,657,649. 4 claims. Nov. 3, 1953. Official Gaz. U. S. Pat. Office, **676**, 1: 141. 1953.

An ice cream tart filling head, consisting of a number of small spouts through which ice cream from the freezer is forced to fill a cup. The bottoms of the spouts are at different levels, and when the head is removed from the cup, depressions are left which are then filled with a confection. R. Whitaker

162. Ice cream stick dispensing machine. R. H. BLOXHAM. U. S. Patent 2,658,652. 3 claims. Nov. 10, 1953. Official Gaz. U. S. Pat. Office, **676**, 2: 485. 1953.

Details are given regarding the construction of a machine for placing sticks into a stick holder for use with frozen novelties made in molds. R. Whitaker

163. Beater mechanism for softening ice cream. N. E. SPIESS, JR., E. M. GROPEN, and K. R. WEAVER (assignors to National Dairy Research Laboratories, Inc.). U. S. Patent 2,657,022. 17 claims. Oct. 27, 1953. Official Gaz. U. S. Pat. Office, **675**, 4: 1053. 1953.

Two horizontal beaters, operating in a housing and driven by a motor, receive an individual serving of ice cream from a hopper and soften it to the consistency of ice cream drawn from a regular ice cream freezer. The beaters fit closely within the housing and completely empty the housing of the product when a discharge gate is opened. R. Whitaker

164. Ice cream bar bagging machine. K. A. BEVINGTON. U. S. Patent 2,656,961. 22 claims. Oct. 27, 1953. Official Gaz. U. S. Pat. Office, **675**, 4: 1035. 1953.

A machine for inserting ice cream bars in individual paper bags. R. Whitaker

MILK AND CREAM

165. Reactivation of milk phosphatase following heat treatment. I. R. C. WRIGHT and J. TRAMER, United Dairies Research Lab., London, Engl. J. Dairy Research, **20**, 2: 177. 1953.

Rapid heating of raw milk to temperatures in excess of 85° C. resulted in reversible inactivation of milk phosphatase. Commercial samples of 'Uperized' milk developed a positive phosphatase reaction on storage. The phenomenon was reproduced in the laboratory and found to depend on the time-temperature relations obtaining during both heating and subsequent storage. Similar results were produced using a bacterial phosphatase. Evidence was adduced showing the similarity between the respective developed phosphatases and the normal alkaline phosphatase of raw milk or the unheated bacterial phosphatase. Attempts to reactivate the phosphatase of milks previously pasteurized were unsuccessful.

J. C. Olson, Jr.

166. The effect of different cream treatments during the pasteurization process on the size distribution of fat globules in cream and butter. R. M. DOLBY, The Dairy Research Institute, Palmerston North, New Zealand. J. Dairy Research, **20**, 2: 201. 1953.

Results of determination of size distribution of fat globules in raw cream and in Vacreator-treated and flash-pasteurized cream produced from the same lot of raw cream are presented.

The Vacreator-treatment given was normal, except that the exit temperature was adjusted to 130° F. The flash pasteurizer used was a tandem beater-type machine. Cream was heated to 160° F. in the first unit and to 200° F. in the second unit, and was sampled after cooling to 130° F. on a surface water cooler.

It is shown that Vacreator-treatment of cream causes a considerable increase in the proportion of fat present as globules less than 2 μ and a small increase in the proportion of globules over 10 μ in diameter. Flash pasteurization caused only a slight increase in the proportion of fat present as small globules and a considerable increase in that present as large globules.

It was demonstrated that butter from Vacreator-treated cream contained fewer large fat globules and fat aggregates than butter from flash-pasteurized cream. It is suggested that this may account for the superior texture of butter made from Vacreator-treated cream as compared with that made from flash-pasteurized cream. E. L. Thomas

167. Cold milk separation of pasteurized milk. L. R. GLAZIER, L. R. DOWD, and A. MANKE, Univ. of Conn., Storrs. Presented at meeting Eastern Div. A.D.S.A. Sept. 20, 1953.

Milk pasteurized by HTST for 17 sec. at 180, 170, and 162° F. respectively was plate cooled to 36° F. and separated with a cold milk separator.

Comparisons were made between the resulting cream and batch pasteurized cream made by separating cold raw milk. Tests run on the cream samples included fat test, coliform and standard plate counts, phosphatase, viscosity, serum separation, whipping ability, cream plug and flavor score.

The batch pasteurized cream from the cold raw separated milk showed better viscosity, less cream plug and serum separation than any of the cream made from separating cold HTST pasteurized milk. The lower the HTST milk pasteurizing temperature, the greater the resulting cream viscosity; the longer the whipping time, the less the cream plug and serum separation. Author's Abstract

168. First world congress for milk utilization. ANON., Milk Prod. J., **44**, 12: 24. 1953.

The activities of this newly formed Congress are briefly presented. The necessity for a continuing Congress was graphically illustrated by the reports of the four main discussion groups under the general chairmanship of Dr. H. C. Trelogan, U.S.D.A.

One group discussing area development endorsed the concept of an area development program which was defined as: "Stimulation of the development of local supplies of wholesome milk and milk products wherever needed, awakening of consciousness of the need, and to foster the exchange of experiences between areas facing similar problems while undergoing development."

The trade and finance groups presented the following views: 1. Technical efficiency of agricultural production is capable of rapid and considerable improvement in all countries. Steps should be taken to secure this improvement in the interests of lower costs and development of countries of low food consumption. 2. Populations existing primarily on vegetable diets are in countries having low worker efficiency. Both government and trade organizations should encourage the use of proteins of animal origin, especially milk. 3. Real surpluses of dairy products do not exist seriously in countries other than the United States. This may be solved by a thorough examination of prices and distribution conditions in terms of consumer acceptance. 4. Temporary national surpluses can and should be used for welfare purposes and the development of new by-products.

If greater attention is paid to present needs of a highly competitive market in terms of consumer acceptability through quality, packaging, distribution and price, private or cooperative enterprise operating freely through normal trade channels is fully capable of distributing present and future dairy product production.

A third group concentrating on technology, health and sanitation, suggested that the Society study all agency-proposals regarding milk utilization to co-ordinate activities of public bodies.

Resolutions also were passed recommending a study by Dairy Industries Society International of the practicability of an international effort to develop dairy product judging standards. J. J. Janzen

169. Melting and solidification of milk fat. H. MULDER, Neth. Milk Dairy J., **7**, 3: 149. 1953.

By means of dilatometric techniques an extensive study was made of the melting and solidification of milk fat. Cream (35% fat) which was stored overnight at 0° C. showed when heated (3-51° C.) the greatest increase in volume between 10 and 20° C. The lower the temp. at which the fat was caused to solidify the lower was the temp. of the maximum in the expansion curve. Direct cooling of liquid fat caused more fat to solidify than step-wise cooling. It was shown that a change in the proportion of solid fat could take place as the result of recrystallization. Dilatometric and calorimetric studies showed that the dispersion of fat affected the solidification. The existence of metastable forms of milk fat was demonstrated by means of the polarizing microscope; fat in the large fat globules of cream could crystallize in the metastable form. The various observations are discussed in the light of the author's hypothesis that milk fat crystallizes in mixed crystals. W. C. van der Zant

170. No-hold pasteurization makes progress. F. W. BARBER, Natl. Dairy Research Lab. Inc., Oakdale, N. Y. Food Eng., **25**, 11: 62. 1953.

The use of higher temperatures and shorter times than employed in conventional pasteurization of dairy products offers opportunity of both quality improvement and economy in plant operations. It is necessary first to determine temperatures which will give bacterial destruction equivalent to present methods. A test organism (MS-102) having suitable characteristics has been used to obtain data on temperature-time relationships for HTST pasteurization of ice cream mix. By reference to a chart prepared from the data, temperature-time combinations for satisfactory pasteurization can be selected. Further studies are needed regarding conditions necessary for "instantaneous" or no-hold pasteurization. T. J. Claydon

171. Factors affecting the chemical composition and physico-chemical properties of milk. ANON., Ky. Agr. Expt. Sta., Lexington. 65th Ann. Rept., 40. 1952.

There was no significant relationship between stage of lactation and the freezing point, titratable acidity, or pH of Jersey and Holstein milk. Specific gravity increased with advancing lactation. In Jersey milk, fat, ash, and protein stability tended to increase as the lactation period advanced. Lactose remained nearly constant in Holstein milk, but decreased in Jersey milk as fat increased. Protein content showed a definite increase with advancing lactation. No seasonal trend was observed in either the fat or lactose content. However, sp. gr. was lower in late spring and titratable acidity of Holstein milk appeared to be higher in the fall, as was the pH of milk of both breeds. Protein was slightly higher in early spring and early fall. Ash content of Jersey milk was low during the summer and the milk of both breeds possessed lower protein stability throughout the spring and summer, and lowest freezing points in spring and fall. R. W. Hunt

172. Changes in milk production in the United States, 1924-51. G. E. BRANDOW, Pa. Agr. Expt. Sta., State College. Progress Rept., 97. 1953.

The changes discussed in this report are milk production, utilization of milk produced, number of dairy cows, milk prices and cow numbers compared among areas, cow numbers and the relation of milk prices of other farm products, heifer and calf numbers as predicators of cow numbers, milk production per cow, trends in feed practices, dairy cow numbers and milk production per cow, year to year changes in production per cow, relation of feed and weather to milk per cow, milk feed prices ratio to milk per cow, and production per cow and market receipts in Philadelphia and New York. Several tables and graphs are presented.
R. W. Hunt

173. Relation of mineral content of summer milk to mineral content of pasture herbage. R. G. Washburn, J. W. Hibbs, and J. D. Sayre, Ohio Agr. Expt. Sta., Wooster. Research Cir., 13. 1953.

Three groups of Jersey cows were used for this pasture experiment. One group was pastured on permanent bluegrass without hay, the second group was on the same pasture as the first only a hay supplement was available at milking time, and the third group was pastured on various legume mixtures without hay. Milk and pasture ashes collected during the experiment (1945, '46, and '47) were analyzed spectrographically. Qualitative analysis of milk ash showed the presence of boran, phosphorus, manganese, magnesium, silicon, iron, aluminum, calcium, copper, silver, sodium, zinc, potassium, molybdenum, chromium, titanium, borium, and strontium. Pasture ashes included all of the above elements plus tin. As measured by the element lithium ratios of the ashes, there appeared to be little correlation between milk ash elements and those of pasture herbage.
R. W. Hunt

174. Reconstituted milk process. D. D. Peebles and M. D. Girvin (assignors to Western Condensing Co.). U. S. Patent 2,657,142. 2 claims. Oct. 27, 1953. Official Gaz. U. S. Pat. Office, **675**, 4: 1086. 1953.

A mixture containing 45 to 89% water, 10 to 52% fat, and 1.2 to 3.1% sodium caseinate is blended, homogenized, canned and sterilized at approximately 240° F. This may be stored until needed in the preparation of reconstituted milk, made by mixing this product with spray dried skimmilk dispersed in water.
R. Whitaker

175. Sediment testing apparatus. D. B. Turner (assignor to Western Condensing Co.). U. S. Patent 2,658,387. 4 claims. Nov. 10, 1953. Official Gaz. U. S. Pat. Office, **676**, 2: 406. 1953.

Two cylinders are attached side by side. One cylinder is used to hold the sample and the other is equipped with a spring loaded pneumatically operated piston. When a handle is swung over the sample chamber, the bottom of the testing chamber is closed with a disc carrying a filter pad and discharge outlet, and the top is closed with a lid carrying a tube for admitting compressed air. The piston is normally held in the open position by the spring and movement of the level pneumatically actuates the piston into the closed position, which in turn acts to seal both ends of the cylinder holding the sample. R. Whitaker

176. Centrifugal separator for cold milk products and the like. H. M. Spross (assignor to The De Laval Separator Co.). U. S. Patent 2,662,687. 6 claims. Dec. 15, 1953. Official Gaz. U. S. Pat. Office, **677**, 3: 745. 1953.

A detailed description is given of the construction of an airtight separator bowl for handling cold milk. R. Whitaker

177. Dairy container sediment trap. P. Kolbet. U. S. Patent 2,661,844. 1 claim. Dec. 8, 1953. Official Gaz. U. S. Pat. Office, **677**, 2: 438. 1953.

A device for removing and collecting the sediment from milk. R. Whitaker

178. Antibiotics in the fluid milk of New York State. R. W. Henningson, G. J. Silberman, and F. V. Kosikowsky, Cornell Univ., Ithaca, N. Y. Ann. Rept. N. Y. State Assoc. of Milk Sanitarians, **25**: 15. 1951. (Chem. Abstr., **47**: 11585i. 1953.)
S. Patton

179. Present status of tests for pasteurization. F. W. Gilcreas, New York State Dept. of Health, Albany. Ann. Rept. N. Y. State Assoc. Milk Sanitarians, **26**: 25. 1952. (Chem. Abstr., **47**: 11586a. 1953.) S. Patton

180. Transfer of heat in surface milk cooler for farms. J. K. Scott, Massey Coll., Palmerston North, New Zealand. Dairy Inds., **18**: 772. 1953. (Chem. Abstr., **47**: 12673d. 1953.)
S. Patton

181. The enzylac process of modifying milk. A. B. Storrs, Armour & Co., Chicago. Certified Milk, **28**, 5: 15. 1953. (Chem. Abstr., **47** 12673e. 1953.) S. Patton

182. Biological detection of antiseptics and antibiotics in milk. J. Pien, J. Lignac, and P. Claude. Ann. fals. et fraudes, **46**: 258. 1953. (Chem. Abstr., **47**: 12676g. 1953.)
S. Patton

MILK SECRETION

183. Persistency of milk yield is influenced by certain factors. K. S. Morrow, N. H. Agr. Expt. Sta., Durham. Bull., 402. 1953.

Thirty-one Holsteins, each with four lacta-

tions, were used in this study. Analysis of data indicated that fall freshening was definitely favored over the other seasons. Age was not a significant factor, and a correlation existed between only the first and second lactations. R. W. Hunt

NUTRITIVE VALUE OF DAIRY PRODUCTS

184. Selling consumers on nutritional value of dairy products. Anon., Milk Products J., **44**, 11: 29. 1953.

The dairy industry has an excellent opportunity to promote the sale of dairy products by advertising products on the basis of nutritional value. The National Dairy Council estimates that 40% of the families in the United States need more calcium, largely supplied by milk; 20% need more vitamin C, supplied by fruits and vegetables; and 10% need more protein supplied chiefly by milk, cheese, meat, and eggs. Educational type of advertising can be of mutual benefit to both the consumer and the dairy industry. J. J. Janzen

185. The effect of heat on the nutritive value of milk proteins as influenced by water and fat. L. J. Schroeder, M. Iacobellis, H. Lees, and A. H. Smith, Wayne Univ. Coll. of Med., Detroit, Mich. J. Nutrition, **50**: 351. 1953. (Chem. Abstr., **47**: 11379d. 1953.) B. L. Larson

186. Problem of heat injury to dietary protein. L. E. Frazier, P. R. Cannon, and R. H. Hughes, Univ. of Chicago. Food Research, **18**: 91. 1953. (Chem. Abstr., **47**: 11379g. 1953.) B. L. Larson

187. Nutritive value for rats of sow milk in comparison with cow milk. R. Braude, K. M. Henry, S. K. Kon, and K. G. Mitchell, Univ. Reading, Engl. J. Dairy Research, **18**: 283. 1951. (Chem. Abstr., **47**: 11383b. 1953.) B. L. Larson

188. Effect of margarine on the reproduction of the mouse. I. K. Mori, Tottori Univ. Igaku to Seibutsugaku, Med. and Biol., **26**: 124. 1953. (Chem. Abstr., **47**: 11389e. 1953.) B. L. Larson

189. Skeletal maturational progress of children with chronic nutritive failure. Effect of dietary supplement of reconstituted milk solids. T. D. Spies, S. Dreizen, R. M. Snodgrasse, G. S. Parker, and C. Currie, Temple Univ., Philadelphia, Pa. Am. J. Diseases Children, **85**: 1. 1953. (Chem. Abstr., **47**: 11390g. 1953.) B. L. Larson

190. Enrichment of milk and butter with carotene and vitamins in the cow. F. Kieferle, Tech. Hochscule, Munich, Ger. Pharmazie, **7**: 291. 1952. (Chem. Abstr., **47**: 11394g. 1953.) B. L. Larson

191. Control of vitamin D in fortified milk. B. Spur, Children's Hosp., Philadelphia, Pa. Certified Milk, **28**, 8: 9. 1953. (Chem. Abstr., **47**: 12673a. 1953.) S. Patton

192. Enrichment of milk with vitamin D. S. Kivenko and A. Titov, Molochnaya Prom., **14**, 8: 30. 1953. (Chem. Abstr., **47** 12676e. 1953.) S. Patton

193. Vitamin enrichment of sour-milk products. E. Volochkova, N. Mironova, S. Egorov, and A. Berezovskaya, Leningrad, Milk Factory 3. Molochnaya Prom., **14**, 6: 40. 1953. (Chem. Abstr., **47**: 10756h. 1953.) S. Patton

PHYSIOLOGY AND ENDOCRINOLOGY

194. Estimation of liver stores of carotenoids and vitamin A in the dairy calf — A preliminary report. C. M. Dembiczak, J. E. Rousseau, Jr., G. Beall, H. D. Eaton, and L. A. Moore, Storrs Agr. Expt. Sta. and the Univ. of Conn., Storrs, and B.D.I., U.S.D.A. Presented at meeting of Eastern Div. A.D.S.A. Sept. 20, 1953.

During 1950-52, 15 Guernsey and 43 Holstein male calves, raised under a limited whole milk-dry calf starter regime, were placed on a vitamin A depletion ration at either 92 or 106 d. of age. Each calf was slaughtered when its blood plasma vitamin A decreased to a randomly assigned level. The liver was then removed for subsequent carotenoid and vitamin A analyses. Several criteria observed immediately prior to slaughter: plasma carotenoids (X_1), plasma vitamin A (X_2), live weight (X_3) and age (X_4), were explored by simple and partial correlation methods as to their association with total liver stores of carotenoids (Y_1) and of vitamin A (Y_2). After establishing the significance ($P \leq 0.05$) or nonsignificance ($P > 0.05$) of the various associations, prediction equations for liver carotenoids and vitamin A were derived by the method of least squares. For Guernseys, these were $Y_1 = 808 + 53.145 X_1$ with applicable limits for plasma carotenoids (X_1) of 5 and 80 γ per cent and $Y_2 = -4955 + 418.634 X_2 + 29.543 X_4$ with limits for plasma vitamin A (X_2) of 5.0 and 17.0 γ per cent and limits for age (X_4) of 110 and 210 days. Corresponding equations for Holsteins were $Y_1 = 260 + 138.763 X_1 - 2.551 X_1^2$ with limits for plasma carotenoids (X_1) of 5 and 40 γ per cent and $Y_2 = 99512 + 1436 X_3 - 802.917 X_3 + 1.485 X_3^2$ with limits for plasma vitamin A (X_3) of 4.0 and 21.0 γ per cent and limits for live weight (X_3) of 280 and 390 lb. Author's Abstract

195. Carotene and vitamin A metabolism in cattle and sheep on phosphorus-deficient ra-

tions. W. D. GALLUP, O. O. THOMAS, O. B. ROSS, and C. K. WHITEHAIR, J. Animal Sci., **12**, 4: 715. 1953.

Nine yearling steers previously depleted of phosphorus and vitamin A stores, were fed a carotene supplement equivalent to 10 times their minimum requirement. Four of the steers were continued on the low-phosphorus ration and five which served as controls were given supplemental phosphorus. The plasma carotene levels at the end of the experiment were 119 mcg. % for the low-phosphorus group and 76 mcg. % for the controls. Plasma vitamin A values for these two groups were 17 and 22 mcg. % respectively. Decreased vitamin A storage in the liver of the phosphorus-deficient steers was indicated. Data collected with sheep indicated that a species difference exists in the vitamin A response of cattle and sheep to phosphorus deficiency. O. T. Stalleup

196. The relationship of surface area to heat tolerance in Jerseys and Sindhi × Jersey (F_1)crossbred cows. R. E. MCDOWELL, D. H. K. LEE, and M. H. FOHRMAN, J. Animal Sci., **12**, 4: 747. 1953.

The surface area of 20 adult Jersey and 20 adult Sindhi × Jersey cows was measured by means of a surface integrator the construction and use of which are given in detail. Neither the ratio of surface area to body weight, nor the ratio of surface area to the two-thirds power of body weight, showed a significant difference between the two groups. The heat tolerance of the two groups was markedly different indicating that differences in heat tolerances of animals such as these are not primarily due to differences in proportional surface area even though the presence of large dewlaps might suggest that such a difference would be found. O. T. Stalleup

197. Repeatibility of an experimental heat tolerance test and the influence of season. R. E. MCDOWELL, C. A. MATTHEWS, D. H. K. LEE, and M. H. FOHRMAN, J. Animal Sci., **12**, 4: 757. 1953.

Repeatability coefficients were calculated for rectal temperature and respiratory rate responses for Jersey and Sindhi × Jersey crossbred cows when subjected for 6 hr. to a standard hot atmosphere (105° F., and vapor pressure 34 mm. Hg). Rectal temperature responses were found to vary markedly with the time of yr.

Repeatability coefficients for the rectal temperature responses in heifers (8-22 mo. of age) remain fairly low until the responses are sorted into three seasonal groups: Apr.-July (low); Aug.-Sept. and Feb.-Mar. combined (high); and Oct.-Jan. (intermediate). They then reach highly significant levels. Repeatability coefficients for respiratory rate responses to the test hot atmosphere remain low, even after seasonal sorting. O. T. Stalleup

198. Environmental physiology and shelter engineering — with special reference to domestic animals. A. C. RAGSDALE, H. J. THOMPSON, D. M. WORSTELL, and S. BRODY, Mo. Agr. Expt. Sta., Columbia. Research Bull., 521. 1953.

Data on milk production and composition, feed and water consumption, and body weight in Holstein, Brown Swiss, Jersey and Brahma cows at low and high relative humidities at various temperatures show that below 75° F. the effect of relative humidity is not significant. The effect of humidity increases with increasing temperature above 75° F. R. W. Hunt

199. Serum alkaline phosphatase activity in Eureopean and Brahman breeds of cattle and their crossbred types. H. O. KUNKEL, D. K. STOKES, W. B. ANTHONY, and M. F. FUTRELL, J. Animal Sci., **12**, 4: 765. 1953.

Serum alkaline phosphatase was determined in a total of 299 cattle which included Angus, Hereford, Jersey, and Holsteins of the European breeds, Brahman breeds, and some cross breeds. The average serum alkaline phosphatase activity of immature Brahman cattle is approximately twice that of the European breeds of the same age. Crossbreeds resulting from crosses between the Brahman and the Hereford or Jersey, and the Santa Gertrude's breed have phosphatase levels which fall between the European and Brahman breeds. Although the alkaline phosphatase activity of bovine serum decreases with age, Brahman cattle continue to have the higher phosphatase levels. Selection for dairy type has little or no effect on serum alkaline phosphatase nor is there a marked difference between sex. Repeatability within breeds is low suggesting a considerable effect of environmental factors. The phosphatase level appears to be negatively correlated with factors affecting rate of gain, efficiency of feed utilization and feed intake. O. T. Stalleup

200. Physiology of calcium metabolism. R. NICOLAYSEN, N. EGG-LARSEN, and O. J. MALM, Nutrition Research Inst., Univ. of Oslo, Norway. Physiol. Rev., **33**, 3: 424. 1953.

Recent advances in the understanding of physiochemical and biochemical processes in the skeleton with special emphasis on the dynamic equilibrium were reviewed. The observation has been made that a period of calcium deprivation was followed by an increased rate of absorption and an increased potential ability for new bone formation or for repair of previous loss of bone tissue. Factors relating to this phenomenon were discussed. E. G. Moody

201. Studies on intravenous administration of calcium, potassium and magnesium to dairy calves. I. Some biochemical and general toxic effects. E. N. BERGMAN and A. F. SELLERS,

Univ. of Minn., St. Paul. Am. J. Vet. Research, **14**, 53: 520. 1953.

Dairy calves varying from 48 to 240 lb. were given continuous intravenous injections of 10% calcium gluconate, 6% $CaCl_2$, 3% KCl, 8% KCl, 12% $MgCl_2$, 1.5% sodium oxalate and mixtures of $MgCl_2$ and $CaCl_2$ at such rates as to produce severe toxic symptoms in about 1 hr. with fatal results in some cases. The rate of injection as well as the blood level reached determined the lethal doses. Maximum safely tolerated rates were 0.07 mEq. of Ca/kg./min. for 45 min., and 0.08 mEq. of Mg/kg./min. for 75 min. Some of the calcium injections were followed by delayed reactions which seemed to be aggravated by excitement. Calcium deaths were due to cardiac failure with severe heart block and ventricular fibrillation, which was preceded by severe cyanosis and dyspnea. Magnesium death was due to respiratory failure following anesthesia which was attained at 10 to 13 mEq./l., accompanied also by cyanosis and dyspnea. Potassium injections caused the calves to become extremely irritable, excitable, and unable to stand, with marked diuresis. Several electrolyte relationships were observed and discussed. E. W. Swanson

202. Passage of molecules through capillary walls. J. J. Pappenheimer, Dept. Physiol., Harvard Med. School, Cambridge, Mass. Physiol. Rev., **33**, 3: 387. 1953.

The evidence suggested that the capillary blood is actually in intimate contact with extravascular fluid and that the microscopically visible flow of blood through the capillaries is, in fact, very small in comparison with the invisible flow of water and dissolved materials back and forth through pores in the capillary walls. The review deals with the physical properties of this ultra-microscopic circulation, its functional structure, the magnitude of flow through it and the physiochemical mechanisms regulating the flow. E. G. Moody

203. Ruminant digestion. A. G. Singleton. Nature, **172**, 4384: 834. 1953.

A report of a discussion held Sept. 8 by the British Association, at Liverpool, England, is presented. Topics included the significance of rate of passage of food through the ruminant stomach, nervous control of ruminant stomachs, absorption from rumen, and the intermediary metabolism of ruminants.

R. Whitaker

204. Qualitative investigation of estrogens and testosterone of bull semen. G. O. Puntriano, Wyo. State Vet. Lab., Laramie. Am. J. Vet. Research, **14**, 53: 542. 1953.

Normal semen from bulls of good fertility was assayed for estrogens by two different methods, but no estrogenic response occurred. Neither an ether extract prepared to isolate estrogens nor the pure bull semen gave any evidence of estrogens. Positive responses for testosterone were obtained from both the ether extract and the pure semen by treatment of seminal vesicles of castrated rats.

E. W. Swanson

205. On the essentiality of the bovine corpus luteum of pregnancy. L. E. McDonald, S. H. McNutt, and R. E. Nichols, Wis. Agr. Expt. Sta., Madison. Am. J. Vet. Research, **14**, 53: 539. 1953.

At various times between 92 and 236 d. of gestation the corpus luteum was removed from each of 13 cows by manual enucleation from the ovary and by surgical removal from the body cavity, either by way of the vagina or the abdominal wall. When the corpus luteum was removed at 92, 101, 115, 143, 163 and 173 d. abortion resulted. A live calf was delivered from one cow at 203 d. following corpus luteum removal at 171 d. A dead calf was delivered from one cow at 244 d. following removal of the corpus luteum at 236 d. Cows from which the corpus luteum was removed at 191, 207, 221, 224, and 230 d. all delivered live calves, with three of them proceeding to normal gestation termination. It appears that the corpus luteum is essential for maintenance of pregnancy in the bovine until about 200 d. and thereafter it may still be essential in certain individuals.

E. W. Swanson

206. Preparation of specimens of oriented sperm heads for x-ray diffraction and infrared-absorption studies and some pseudo-molecular behavior of sperm. M. H. F. Wilkins and B. Battaglia, Sta. zool., Naples. Biochem. et Biophys. Acta, **11**: 412. 1953. (Chem. Abstr., **47**: 11308f. 1953.) B. L. Larson

207. Problems associated with copper deficiency in ruminants. H. R. Marston, Univ. Adelaide, Australia. Symposium on Copper Metabolism. Johns Hopkins Press, 230. 1950. (Chem. Abstr., **47**: 11377c. 1953.)

B. L. Larson

208. The nutritive value of colostrum for the calf and the effect of soybean lecithin on the vitamin A absorption and on the growth rate of calves given small quantities of separated colostrum. R. Aschaffenburg, S. Bartlett, S. K. Kon, J. H. B. Roy, H. J. Sears, S. Y. Thomson, P. L. Ingram, R. Lovell, and P. C. Wood, Roy Vet. Coll., Camden Town, London. Brit. J. Nutrition, **7**: 275. 1953. (Chem. Abstr., **47**: 11387b. 1953.) B. L. Larson

209. Preliminary study of the relations between the blood mineral composition of dairy cows and the milk and milk fat yield simultaneously obtained. P. Saarinen, Helsinki Univ. Maataloustieteellinen Aikakauskirja, **24**: 170. 1952. (Chem. Abstr., **47**: 11395h. 1953.) B. L. Larson

210. Sympathomimetic activity of organ extracts of cow and horse. G. PEETERS, P. FISCHER, and J. LECOMTE, Univ. Liége, Belg. Arch. intern. pharmacodynamie, **94**: 201. 1953. (Chem. Abstr., **47**: 11404d. 1953.)
B. L. Larson

211. Effects of anterior hypophysis on mammary glands and adrenals. R. SILBERBERG, M. SILBERBERG, and M. OPDYKE, Hosp. Div., City of St. Louis, Mo. Arch. Pathol., **55**: 506. 1953. (Chem. Abstr., **47**: 11405d. 1953.)
B. L. Larson

212. Hormonal mechanism of mammary development and lactation. S. HAFEZ, Cairo Univ., Egypt. Acta Endocrinol., **13**: 193. 1953. (Chem. Abstr., **47**: 11423f. 1953.)
B. L. Larson

213. Metabolism of acetylcholine in animal spermatozoa. I. Choline acetylase in pig spermatozoa. T. SEKINE, Univ. Tokyo. Igaku to Seibutsugaku Med. and Biol., **24**: 115. 1952. (Chem. Abstr., **47**: 11429b. 1953.)
B. L. Larson

214. Phosphatases of organs. I. Mammary gland phosphatases. III. Phosphatases of the mammary gland at various stages. H. OTA, Arb. dritt. Abt. anat. Inst. kaiserl. Univ. Kyoto, Ser. C. Exptl. Tuberk, **6**: 6; 21. 1940-1945. (Chem. Abstr., **47**: 11433b. 1953.)
B. L. Larson

215. Digestion of ruminants. III. Hypoglycemia and insulin ketosis in the goat. M. UMEZU, A. SHIBATA, and S. MINAGAKI, Tohoku Univ., Sendai. Tohoku J. Agr. Research, **3**: 93. 1952. (Chem. Abstr., **47**: 11440a. 1953.)
B. L. Larson

216. Effect of the administration of Helichrysum italicum extract on the vitamin C content of sheep milk. D. GIANNOTTI, Univ. Pisa, Italy. Ann. facoltà med. vet. univ. Pisa, **4**: 140. 1951. (Chem. Abstr., **47**: 11556d. 1953.)
B. L. Larson

217. Hyaluronidase activity in the preservation of bull semen. H. TAKAMINE, Tokyo Univ. of Agr. and Technol. Igaku to Seibutsugaku (Med. and Biol.), **25**: 86. 1952. (Chem. Abstr., **47**: 10581a. 1953.)
B. L. Larson

218. A statistical study of the interrelations between certain mineral constituents of the blood of dairy cows. P. SAARINEN, Agr. Research Center, Tikkurila, Finland. Maataloustieteellinen Aikakauskirja, **25**: 9. 1953. (Chem. Abstr., **47**: 10668e. 1953.)
B. L. Larson

219. Plasma and blood volumes in the cow using the T-1824 hematocrit method. M. REYNOLDS, Univ. Pennsylvania, Philadelphia. Am. J. Physiol., **173**: 421. 1953. (Chem. Abstr., **47**: 10670a. 1953.)
B. L. Larson

220. Propionate as a precursor of milk constituents in the intact dairy cow. M. KLEIBER, A. L. BLACK, M. A. BROWN, and B. M. TOLBERT, Univ. California, Davis. J. Biol. Chem., **203**: 339. 1953. (Chem. Abstr., **47**: 10674i. 1953.)
B. L. Larson

221. The possibility of penetration of ethylene chloride into the milk of a nursing mother exposed to it. T. P. URUSOVA. Gigiena i Sanit., **3**: 37. 1953. (Chem. Abstr., **47**: 10721g. 1953.)
B. L. Larson

222. The effects of potassium and calcium salts on the motility of ram, rabbit, and bull spermatozoa. A. W. BLACKSHAW, Univ. Sydney. J. Physiol. (London), **120**: 465. 1953. (Chem. Abstr., **47**: 10664d. 1953.)
B. L. Larson

223. Galega officinalis, a plant, poisonous for ruminants. R. MORQUER, P. RIVALS, and L. ANDRAL. Rev. méd. vét., **103**: 327. 1953. (Chem. Abstr., **47**: 12696g. 1953.)
S. Patton

224. A chemical reaction for detecting functional alterations of the milk secretion, inflammations of the mammal gland, and the abnormal composition of milk. V. SACCO. Latte, **26**: 482. 1952. (Chem. Abstr., **47**: 11583g. 1953.)
S. Patton

225. Uptake of plasma amino acids by the perfused isolated cow udder. J. H. BOUCKAERT, W. OYAERT, G. PEETERS, and G. SIERENS, Univ. Ghent, Belg. Arch. intern. pharmacodynamie, **93**: 443. 1953. (Chem. Abstr., **47**: 11404c. 1953.)
B. L. Larson

SANITATION AND CLEANSING

226. Aerobic treatment of dairy wastes. N. PORGES, L. JASEWICZ, and S. R. HOOVER, Eastern Reg. Research Lab., Philadelphia, Pa. Appl. Microbiol., **1**, 5: 262. 1953.

Using synthetic dairy waste, it was demonstrated that about 62.5 % of the BOD was converted to cell protoplasm and the remainder oxidized for energy. Further aeration after the rapid growth phase accelerated autodigestion of the cell by endogenous respiration. During assimilation, the oxygen demand of the organisms was high, indicating that oxygen was used at 10 times the rate necessary for the endogenous phase. Maintaining aerobic conditions is necessary during the oxidative processes, which requires an oxygen tension ranging from 0.3 to 0.5 ppm in solution. The assimilation requires 6 hr. for completion, while

the endogenous phase requires 16 hr. to oxidize the assimilated material.

The aeration process as used in treating dairy waste successfully converts high oxygen-demanding wastes into cell substances of lower BOD. H. H. Weiser

227. New ideas from field developments. W. H. Mair, Bowman Dairy Co., Chicago. Southern Dairy Prod. J., **54**, 4: 132. 1953.

Good can washing requires proper maintenance of the washer, daily cleaning with brush or steam power, a 2 to 4 position stainless steel drain section, utilization of waste wash water as a pre-rinse, 170-175° F. wash temperature, sterile rinse control to finish cans near pH 7, adequate draining time before drying, cold air drying with rising jets, balanced ducts for removal of steam but avoiding excessive air circulation, avoiding overfilling of boiler which may result in milkstone from carry-over, and a 2-speed motor or variable speed drive to allow more time for cleaning the dirtier cans. F. W. Bennett

228. A comparison of the most probable numbers of coliform bacteria and enterococci in raw sewage. W. Litsky, M. J. Rosenbaum, and R. L. France, Dept. of Bacteriol., Univ. of Mass., Amherst. Appl. Microbiol., **1**, 5: 247. 1953.

Enterococci were detected by using azide dextrose broth (Difco). A positive correlation of +0.9 existed between the numbers of coliform organisms and enterococci in sewage from settling tanks. H. H. Weiser

229. Toxicity of vapors of four chlorinated hydrocarbon insecticides to resistant house flies. H. G. Wilson, J. B. Gahan, and W. C. McDuffie, U.S.D.A., Agr. Research Adm., Bur. of Entomol. and Plant Quarantine. J. Econ. Entomol., **46**, 4: 699. 1953.

Laboratory tests were made to determine whether house flies resistant to contact with either lindane, chlordane, dieldrin, or aldrin also were resistant to their vapors. Resistance of the various fly strains to vapors of the four insecticides was rather closely correlated with their resistance to lindane residues, and less closely with resistance to DDT residues. Insecticidal vapor control of resistant flies required too much time to warrant such use in actual practice. E. H. Fisher

230. Effectiveness of lindane vaporizers. R. A. Fulton, W. N. Sullivan, and G. F. Mangan, Bur. of Entomol. and Plant Quarantine, Agr. Research Adm., U.S.D.A. J. Econ. Entomol., **46**, 4: 639. 1953.

Lindane vaporizers were tested in a rectangular room of about 11,000 cu. ft. capacity, and at 85° F. Vaporizers were mounted on walls, about 6 ft. from the floor, and 5 ft. from the ceiling. Vaporizers were adjusted to 118° C., intended to disperse about 1 g. of lindane per d.

Tests with a single vaporizer showed variation in lindane vapor concentration at various points in the room, whether closed or ventilated by means of doors and windows. The lindane concentration generally decreased with increased ventilation, but air conditioning units had little effect. Non-resistant flies exposed in the closed room for an hr. were all killed. It required 3 hr. to achieve 62% control with the three windows and two doors open. Under closed conditions one vaporizer gave 90% control of brown-banded cockroaches in 1 d., but 11 d. were required to achieve similar results with German and oriental roaches; less than two-thirds of the American roaches were killed in 11 d., and confused flour beetles and carpet beetle larvae were practically not affected.

Tests with four vaporizers in the room showed greater efficiency. E. H. Fisher

231. Action of some aliphatic thiocyanates against DDT-resistant strains of the house fly. C. Gustafson, Jr., T. Lies, and T. Wagner-Jauregg, Med. Chem. Br., Chem. Corps Med. Lab., Army Chem. Center, Md. J. Econ. Entomol., **46**, 4: 620. 1953.

Some aliphatic thiocyanates were tested as contact insecticides against the house fly. Though not as effective as DDT against normal strains of flies, some materials were superior against DDT-resistant strains. There was considerable variation between materials in relation to undesirable odor, and to mammalian toxicity (mice were the test mammals). E. H. Fisher

232. Chemotherapeutic use of insecticides for control of bloodsucking insects. A. W. Lindquist, A. R. Roth, R. A. Hoffman, and W. W. Yates, U.S.D.A., Agr. Res. Adm., Bur. of Entomol. and Plant Quarantine, and P. O. Ritcher, Ore. State Coll. J. Econ. Entomol., **46**, 4: 610. 1953.

In Ore., during the summer of 1952, subcutaneous injections of peanut oil solutions of several insecticides into mice and dairy cattle were made. Control of specific tabanids, mosquitoes, and of horn flies was studied.

Dieldrin gave good control of deer flies, and aldrin was slightly less effective, but mosquito control was poor with each material. Heptachlor was more effective against mosquitoes. Poor to no toxicity was exhibited with lindane, DDT, TDE, methoxychlor, toxaphene, Q-137, the fluoro analog of DDT, the butyl analog of DDT, and some sulfones.

Neither aldrin, dieldrin, allethrin, nor heptachlor injected in cattle gave good control of tabanids and mosquitoes. Lindane was effective against mosquitoes and horn flies, but less effective against deer flies.

Some injected mice and cattle died during the trials. E. H. Fisher

233. Bottle carrying pocket. J. B. McCabe and A. H. Luedicke, Jr. (assignors to Cherry-Burrell Corp.). U. S. Patent 2,660,290. 12 claims. Nov. 24, 1953. Official Gaz. U. S. Pat. Office, **676**, 4: 1090. 1953.

A pocket is described for holding milk bottles, for use in bottle washing machines, etc., and consisting of a pocket with an open bottom and two small roller-shaped devices on the rim of the constricted end for holding the bottle in the pocket. R. Whitaker

234. Relation between index of putrescibility and oxidation-reduction potential in dairy sewage. L. Coin and M. Mathis, Service contrôle eaux, Paris. Bull. centre belge étude et document. eaux (Liége), **16**: 144. 1952. (Chem. Abstr., **47**: 11616f. 1953.) S. Patton

235. The New York State water-pollution-control program in relation to milk wastes. W. H. Larkin, New York State Dept. of Health, Albany. Ann. Rept. N. Y. State Assoc. Milk Sanitarians, **25**: 65. 1951. (Chem. Abstr., **47**: 11617a. 1953.) S. Patton

236. Waste waters from the butter factories. V. Tregubov. Molochnaya Prom., **14**, 6: 26. 1953. (Chem. Abstr., **47**: 10757h. 1953.) S. Patton

Detect 1ST Signs of Sediment

RAPID-FLO®

Fibre-Bonded

FILTER DISKS

Catching causes of sediment at the very start saves time and improves milk quality. That's why fieldmen recommend the Rapid-Flo Farm Sediment Check-Up. J & J's exclusive Fibre-Bonding process makes Rapid-Flo Filter Disks safer, stronger and more retentive, a reliable Farm Sediment Check-Up.

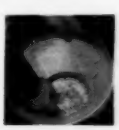
Fieldmen and sanitarians find their jobs made easier in up-grading milk when they receive the cooperation of farmers who can see for themselves the necessity of eliminating substandard milk.

THESE FACTS ARE WELL KNOWN!

A recent coast-to-coast survey of over 175,000 farmers, made by an independent research organization, revealed that Rapid-Flo Fibre-Bonded Filter Disks are the farmers' choice *2-to-1 over the next three leading brands combined!*

THE *RAPID-FLO* FARM SEDIMENT CHECK-UP

1. After filtering each can of milk (10 gallons or less), the producer should carefully remove the used filter disk from the strainer and place it on a cardboard to dry.



2. When filter disk is dry, it should be examined closely. The producer can identify the sediment or extraneous matter to determine its origin, and take precautions to prevent its recurrence.

Urge your producers to use genuine Rapid-Flo Fibre-Bonded Filter Disks — available in Bonded Face, Single Gauze Face and Double Gauze Face types

FILTER PRODUCTS DIVISION

Johnson & Johnson

4949 WEST 65th STREET
CHICAGO 38, ILLINOIS

Your advertisement is being read in every State and in 45 Foreign Countries

Now Available . . .

a limited supply of the new

DECENNIAL INDEX

of the JOURNAL OF DAIRY SCIENCE

Covering Volumes XXI-XXX. All Copies Clothbound.

COST: Members, $6.50 Non-Members, $7.50

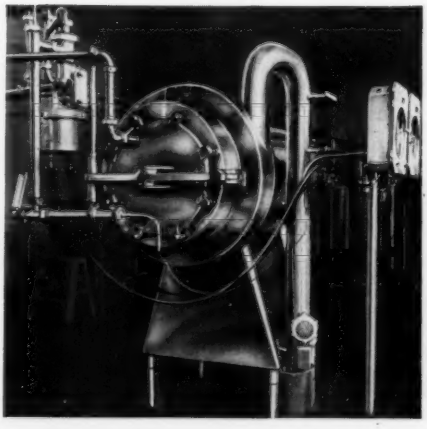
Send check or money order to the

AMERICAN DAIRY SCIENCE ASSOCIATION

Ohio State University **Columbus 10, Ohio**

More Preheating Capacity in *Half* the Floor Space!

Mojonnier 84-5 Tubular Heater in Philadelphia Dairy Products Company's Athens St. plant, Ardmore, Pa. This unit has special highly polished stainless steel finish and meets the sanitary standards of Ardmore County, considered among the highest in the world.



● Philadelphia Dairy Products Co. recently replaced a shell and tube preheater with a Mojonnier Tubular Heater. The unit replaced was 12 feet long, and had 32 two inch tubes. The capacity was 6,000 pounds per hour.

● The new Mojonnier Tubular Heater is only 5 feet long and has 84 one inch tubes. It is operated at 6,000 pounds of raw milk per hour heated from 38° to 145° F. and has a maximum capacity of 8,000 pounds per hour. The Mojonnier Heater corrected unfavorable working conditions created by the old heater, which leaked steam and hot water. Cleaning, which can be accomplished by recirculation of acid and alkali solutions, is much easier with the new unit.

● For information on the Mojonnier Tubular Heater, contact your nearest Mojonnier salesmen, or write:

MOJONNIER BROS. CO., 4601 W. OHIO ST., CHICAGO 44, ILL.

Mojonnier TUBULAR HEATERS

Mojonnier Engineered Equipment for the Dairy Industry Includes: VACUUM PANS • COLD-WALL TANKS • COMPACT COOLERS • CONVEYORS • ZONE CONTROL VATS • EVAPORATORS • TUBULAR HEATERS • TUBULAR COOLERS MILK TESTERS • VACUUM FILLERS • CASE WASHERS • BULK COOLERS • BULK TANKERS • BALANCE TANKS • CUT-WRAP MACHINES • OVERRUN TESTERS • CULTURE CONTROLLERS • BUTTER PRINT SCALES • PROCESSED CHEESE KETTLES

REVOLUTIONARY NEW CLEANING METHOD FOR HIGH TEMPERATURE EQUIPMENT

Chelation

AND WHAT IT MEANS IN SAVINGS

KLENZADE

O-R SYSTEM OF CLEANING

Again Klenzade leads with a remarkable new cleaning chemistry advance — Chelation. Initial cleaning with Klenzade O-R Organic Acid Cleaner is followed with Klenzade O-R Alkaline Cleaner. This produces an amazing series of chemical reactions — each one super-powered for a variety of specific cleaning actions never even approached before. "Chelation" prevents precipitation of water-borne minerals and assures film-free surfaces. Let us demonstrate to you that this revolutionary chemical cleaning advance — the Klenzade O-R System — will definitely save you hundreds of dollars annually.

Write for Details

ORGANIC ACID CLEANER • Single Cycle Cleaning • ALKALINE CLEANER

KLENZADE PRODUCTS, INC.
BELOIT, WISCONSIN
Branch Offices and Warehouses in Principal Cities

Reg. U. S. GBI Pat. Off.

FRIGIDRY
Reg. U. S. Pat. Off.
DAIRY CULTURES

Frigidry lyophilized dairy cultures help take the guesswork out of buttermilk, cottage cheese and Yoghurt production. They are produced by sub-zero, high vacuum techniques resulting in a uniform and quick acting culture for providing optimum acidity and aroma in mother culture. Save Time—Save Money—Avoid Trouble.

Frigidry lyophilized dairy cultures are supplied in sealed serum bottles each containing 2 grams of dry powder. Each bottle makes 1 quart of mother culture. Frigidry cultures are guaranteed to give satisfaction or will be replaced free of charge.

Order through your
Dairy Jobber or Direct

Standard Culture	$2.75 Postpaid*
Yoghurt Culture	3.00 Postpaid

* $2.50 on standing orders

WRITE FOR

Write for folders giving full information on and directions for using Frigidry cultures—also literature describing G.B.I. Ice Cream Stabilizers and Emulsifiers.

GENERAL BIOCHEMICALS, INC.
20 LABORATORY PARK • CHAGRIN FALLS, OHIO

Your advertisement is being read in every State and in 45 Foreign Countries

Copies of the

20-YEAR INDEX

covering Volumes I to XX, inclusive are available at the following prices:

★ ★ ★

MEMBERS		NON-MEMBERS	
Cloth Bound	$2.35	Cloth Bound	$5.50
Paper Bound	2.00	Paper Bound	5.00

Your advertisement is being read in every State and in 45 Foreign Countries

DIFCO

CULTURE MEDIA

for Examination of Milk

BACTO-PLATE COUNT AGAR (TRYPTONE GLUCOSE YEAST AGAR)

is recommended for use in determining the total bacterial plate count of milk in accordance with the new procedure of "Standard Methods for the Examination of Dairy Products" of the American Public Health Association. This media does not require addition of skim milk.

Upon plates of medium prepared from Bacto-Tryptone Glucose Extract Agar colonies of the bacteria occurring in milk are larger and more representative than those on media previously used for milk counts.

BACTO-PROTEOSE TRYPTONE AGAR

is recommended for use in determining the bacterial plate count of Certified Milk. The formula for this medium corresponds with that suggested in "Methods and Standards of Certified Milk" of the American Association of Medical Milk Commissions.

BACTO-VIOLET RED BILE AGAR

is widely used for direct plate counts of coliform bacteria. Upon plates of this medium accurate counts of these organisms are readily obtained.

BACTO-BRILLIANT GREEN BILE 2%

BACTO-FORMATE RICINOLEATE BROTH

are very useful liquid media for detection of coliform bacteria in milk. Use of these media is approved in "Standard Methods."

Specify "DIFCO"

THE TRADE NAME OF THE PIONEERS
In the Research and Development of Bacto-Peptone and Dehydrated Culture Media

DIFCO LABORATORIES
DETROIT 1, MICHIGAN